

THE *A. REED*
ANATOMY
OF THE
HUMAN BODY

ABRIDGED:

James Keill
OR,

A SHORT and FULL VIEW of all
the PARTS of the BODY.

TOGETHER WITH
Their several USES, drawn from their
COMPOSITIONS and STRUCTURES.

By JAMES KEILL, M. D.

The FOURTEENTH EDITION, Corrected.

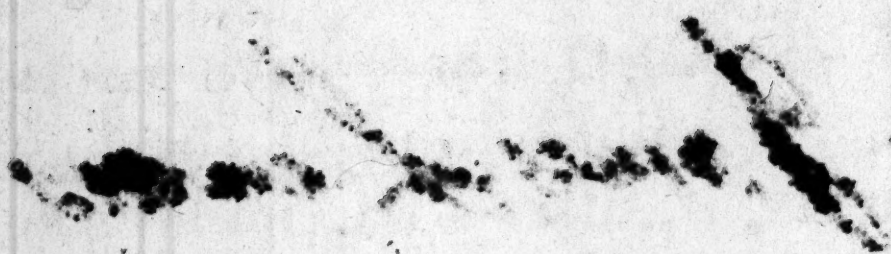
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James Lemmon

T O

EDWARD TYSON.

DOCTOR of PHYSIC.

I WOULD scarce have adventured the publishing of the following sheets, if, after a particular and careful perusal, you had not been pleased to advise and encourage me to it ; and I desire the favour of prefixing your Name to them, that the world may know your approbation, which will sufficiently secure me from censure, and recommend them, as containing something exact and useful : For your skill and judgement in this subject is well known, and abundantly demonstrated by those treatises with which you have obliged the world ; and the Publick Lectures, by which you have adorned the honourable and useful office you have held for several years.

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BUT

DEDICATION.

BUT yet I am not so vain as to think there are no slips nor errors in this little treatise, nor will I impose so far on your goodness and civility, as to expect your patronage of them; I only hope, that, after your example, others will be so candid and civil as to pass them over.

I DO also readily accept of this occasion, to pay my most hearty acknowledgements for your private favours and civilities. And as I have a true esteem for your merits, so I shall be always ready to shew myself

Your most humble

and obliged servant,

JAMES KEILL.

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T H E
A N A T O M Y
O F T H E
H U M A N B O D Y
A B R I D G E D.



C H A P. I.

Of the component, external, and common Parts of the Body.

S E C T. I.

Of the component Parts.

I PURPOSELY pass over the various definitions of a part, as being of no great use; and for the same reason I will not trouble the reader with the several divisions which anatomists make of the parts of the Human Body: It is sufficient to know, that all the parts are made up of threads, or fibres, All the parts of which there be different kinds; for there are some soft, flexible, and a little elastick; ^{are made up of fibres.}
A and

Of the Component Parts.

and these are either hollow like small pipes, or spongy, and full of little cells, as the nervous and fleshy fibres; others there are more solid and flexible, but with a strong elasticity, or spring, as the membranous and cartilaginous fibres; and a third sort are hard and inflexible, as the fibres of the bones. Now, of all these, some are very sensible, and others are destitute of all sense; some so very small as not to be easily perceived; and others, on the contrary, so big as to be plainly seen. And most of them, when examined with a microscope, appear to be composed of still smaller fibres.

Now these fibres do first constitute the substance of the bones, cartilages, ligaments, membranes, nerves, veins, arteries and muscles. And again, by the various texture, and different combination of some or all these parts, the more compound organs are framed; such as the lungs, stomach, liver, legs and arms, the sum of all which make up the body.

S E C T. II.

Of the external Parts.

The division
of the body.

THE body is divided into four principal parts, which are, the head, the thorax, the abdomen, and the extremities, *viz.* the arms and legs.

The external
parts of
the head.

The external parts of the head, or upper cavity, are, the face, and the clava, or hairy scalp. The parts of the face are, the brow,

Of the External Parts.

brow, the ears, the eyes, the cheeks, the nose, the *philtrum* and its sides, the mustaches, the lips, the mouth, and the chin. The parts of the hairy scalp are, the *sinciput*, or forehead; under which lieth the *os frontis*: It reaches to the *regis*, or meeting of the coronal with the sagittal future. The *vertex*, or crown of the head, is where the hairs turn as it were round a point; and from thence to the first joint of the neck, is the *occiput*, or hind-head. The temples are the sides of the hairy scalp, under which are the crotaphite muscles, the *ossa petrosa*; they reach to the *sutura squamosa*.

The external ear is divided into two parts, Of the ear. of which the upper is called *pinna*, or the wing; the lower, *fibra*, or lobe. The parts of the *pinna* are, the *helix*, which is the outward circle or border of the ear; the *anti-helix*, which is the semi-circle within the other: The lower end of the semi-circle makes a little prominence, which is called *antitragus*; because there is another prominence just opposite to it, which is called *tragus*, by reason of some hair that is upon it. The cavity made by the extremities of the *helix* and *anti-helix* is called *concha*: The hollow in the middle of the ear is called *alvearium*; it has a hole which leads to the *tympanum*, named the *meatus auditorius*.

The external parts of the eyes are, Of the eyes. the *supercilia*, or eye-brows; the *canthus internus*, or the great angle, where the *carunculus lacrymalis* is; the *canthus externus*, or the little angle, which is the farthest from the nose; the *palpebrae*, or the upper and lower

Of the External Parts.

eye-lids: the *cilia*, which are little cartilages on the edge of the eye-lids: the hairs planted upon the cilia, in form of a palisado; the *puncta lachrymalia*, which are two little holes near the big angle of the eye. The orbit is a cavity made by the bones, in which the globe of the eye is contained, with its six muscles; the *tunica conjunctiva*, which is the white of the eye; the *cornea*, which is the transparent part of the eye; the *iris*, or rainbow, in the middle of which is the *pupilla*, or sight.

Of the nose,
lips, &c.

The nose has its *spina*, or ridge, which is long. The *acrorision*, which is cartilaginous, and reaches from the end of the spine to the *globulus*, or tip of the nose. The nostrils are the passages into the nose. The *alæ*, or wings of the nose, are the sides of the nostrils. The *columna* is the little fleshy portion which reaches from the tip of the nose to the *philtrum*; it divides the nostrils. The *philtrum* is the hollow which divides the upper lip immediately under the nose. The cheeks reach from the lower eye-lids to the lips. The *mentum*, or chin, is the fore-part of the lower jaw. The lower jaw reaches from the two ears to the chin, inclusively. The lips are the musculous flesh at the entry of the mouth; their external part is called *prolabium*, and that which is tinged red *prosthomion*. The gums are the flesh which covers the lower part of the teeth.

Of the neck,

The neck reaches from the head to the *clavicula*, or channel-bones. Its parts are the *jugulum*, or throat, which is its fore-part,
along

Of the External Parts.

along which descends the *trachea arteria*, or wind-pipe, and the *oesophagus*, or gullet. The eminence which appears in the upper part of the throat, is called *pomum Adami*. The *cervix*, which is the hind part of the neck; its upper part is called *lophia*, the middle *fossa*, and the lower *epomis*. The *parotides* make the upper and lateral part of the neck, *terthra* the middle, and *paralophia* the lower.

All that lies betwixt the basis of the neck, and the *diaphragma*, or midriff, that is, down to the last ribs, is called the *thorax*, or chest. The fore-part of the *thorax* is called the breast; in it are the *claviculae*, or channel-bones: and the *sternum*, or breast-bone, which is in the middle; it begins at the *claviculae*, and terminates in the *cartilago-xiphoides*, or sword-like cartilage. Under the *sternum* lies the *mediastinum*, and the heart in its *pericardium*. The *mammæ*, or breasts, are two round tumours, which appear upon the fore-part of the chest, under which are situated part of the ribs, the *pleura*, and the lungs: there stands upon their centre a little protuberance, called *papilla*, or nipple, which is encompassed with a reddish circle, called *areola*. The hollow in the middle of the breast, below the breasts, is called *scrobiculis cordis*. The hinder part of the *thorax* is called the back, composed of twelve *vertebrae*, or joints, and two *scapulae*, or shoulder blades, which are the two upper parts of the back on the sides of the *vertebrae*. The lateral parts of the *thorax* are called *peristerna*.

Of the external parts of the thorax, or middle cavity.

Of the external parts of the abdomen, or lower belly.

The lower belly extendeth from the *cartilago-xiphoides* to the *os pubis*; the fore part is called *abdomen*, and the hinder part the back-side. The *abdomen* is divided into upper, middle, and lower parts.

The upper reaches from the *cartilago-xiphoides*, till within two fingers breadth above the navel; it is called *epigastrium*, and its two sides *hypochondria*: the right covers the greatest part of the liver; the left the spleen, part of the stomach, and *colon*. The middle part of the *abdomen* is only two fingers breadth above, and as much below the navel; it is called *regio umbilicalis*; its middle is called *umbilicus*, or navel. Under the middle of this region lies the *intestinum jejunum*, and part of the *ilium*. The sides of this region are called by Glisson *epicolicae*, because they cover the *colon*. Under the right is contained the right kidney, with part of the *colon* and *jejunum*: under the left is contained the left kidney, with part of the *colon* and *jejunum*. The lower part of the *abdomen* reaches from the umbilical region to the lower part of the *os pubis*; it is called the *hypogastrium*; it covers the bladder, womb, and the *rectum*, or straight gut. The lower part of the *hypogastrium* is called *pecten*, or *regio pubis*; its sides *inguina*, or groins. The sides of the *hypogastrium* are called *ilia*, either because they contain almost all the gut *ilium*, or because they terminate at the lower part of the *os ilium*. The *inguina*, or groins, are below the *ilia*, where there is a part of the muscle *cremaster*, with the productions of the *peritoneum*. The hind part of the *abdomen* is called the

Of the External Parts.

the back-side ; it reaches from the last ribs to the extremity of the *os sacrum*. It is divided into two parts. The upper is called the small of the back, its sides, the loins; the middle of the lower part is called *radius*; as its lower end is the *anus*, and its sides the *nates*, or buttocks. The *perinæum* is the space between the *anus* and the *scrotum* in men, and the *vulva* in women.

The external parts of generation proper to men are, the yard and the *scrotum*. The extremity of the yard is called the *glans*. The *preputium*, or fore-skin, is the skin doubled, which covers the *glans* like a hood. The *frænum*, or bridle, is a little whitish-coloured ligament, which ties the fore skin and the *glans* together beneath. The edge of the *glans*, where the *preputium* begins, is called *corona*, or crown. The *urethra* is the canal which runs along the under side of the yard, through which the seed and the urine pass. The *rapha*, or ridge, is a line, which running along the under side of the yard, divides the *scrotum* and *perinæum* in two; its length is from the *frænum* to the *anus*. It is not ordinarily cut in the operation for the stone; first, because it is harder than any other part of the skin there, and then cutting upon the interstices of the muscles, the sides of the wound do not so easily unite. The *scrotum* is the purse which contains the two testicles.

The external parts of generation proper to women are, the *vulva*, or great chink, situated below the *os pubis*, and covered with hair; above this there is a little swelling

made

Of the External Parts.

made by some fat under the skin, which is called *mons veneris*. The *labia*, or lips of the great chink, are only the skin swelled by some fat underneath; these being a little separated, there appear the *nymphae*, one on each side of the chink; they are two small pieces of flesh, resembling the membranes that hang under the throats of pullets. In the angle of the great chink, next the *os pubis*, is the extremity of the *clitoris*, covered with a little hood of the skin, called *præputium*. A little deeper, on the same side of the *vulva*, there is a little hole, which is the orifice of the neck of the bladder. On the opposite side, next the *anus*, are *glandulae myrtiformes*, situated in the *fossa magna*, or *navicularis*; and in this angle of the chink there is a ligament called the fork, which is torn in the first birth.

Of the external parts of the arms, fore-arms, and hands.

The arm is from the joint of the shoulder to the elbow, which is the place where we bend our arm. The fore-arm is from the elbow to the wrist, or *carpus*. The hand is all that which is betwixt the wrist and the ends of the fingers. The parts of the hand are, the *metacarpus*, which is from the wrist to the root of the fingers; the out-side, which is the back of the hand; and the in-side, which is the palm of the hand; the *mons pollicis* is the fleshy part of the hand nigh the thumb; the finger next the thumb is called the *index*, or fore-finger; then follows the middle, the ring-finger, and the little one. Upon the extremities of the fingers are the nails; the white spot, which is at the root of the nails, is called *onyx*.

The

Of the External Parts.

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The thigh is from the haunch to that joint of which the fore-part is called the knee; the back-part the ham.

Of the external parts of the thigh and leg.

The leg is from the knee to the *tarsus*; its fore-part is called the shin, and the back-part, the calf of the leg: the eminences, which are at the extremity nigh the *tarsus*, are called the outer and inner ankles of the foot: the *tarsus* is from the ankles to the *metatarsus*, or breadth of the foot, which goes to the root of the toes: the upper part of the foot is called instep; the under part, the sole of the foot: the toes are five in number, with their nails.

S E C T. III.

Of the common Parts of the Teguments.

Of the EPIDERMIS OR CUTICULA.

THE first and outermost covering of the body is the *cuticula*, or scarf-skin, by the Greeks called *ἐπίδερμις*. This is that soft skin which rises in a blister upon any burning, or the application of a blistering plaister. It sticks close to the surface of the true skin. to which it is also tied by the vessels which nourish it, tho' they are so small as not to be seen. When we examine the scarf-skin with a microscope, it appears to be made up of several lays, of exceeding small scales, which cover one another, more or less according to the different thickness of the scarf-skin, in the several parts of the body.

In

In the lips, where the scales appear plainest, because the skin is thinnest, they only, in a manner touch one another. Now these scales are either the excretory ducts of the glands of the true skin, as, I think, is apparent in fishes; or else these glands have their pipes opening between the scales. Leuwenhoeck reckons, that in one cuticular scale there may be five hundred excretory channels, and that a grain of sand will cover two hundred and fifty scales: so that one grain of sand will cover one hundred twenty five thousand orifices, through which we daily perspire.

The scales are often glewed to one another by the grosser parts of our insensible transpiration, hardening upon them by the heat of our body, which carries off the more volatile particles. The humour which is afterwards separated by the glands of the skin, being pent in between the scales, causes frequent itchings, and where the matter has been long pent up, small pimples; for the removing of which, nature directs to those wholesome remedies of frequent rubbing, and washing or bathing.

The use of the scarf-skin is to defend the nerves of the skin, which are the origin of the sense of feeling, from the injuries of rough and hard bodies, as well as the air; for either those would make too exquisite and painful an impression upon the naked nerves; or the air would dry them, so as that they would be less susceptible of the nicer touches of pleasure.

S E C T. IV.

Of the Skin.

WE remark in the skin, the scarf-skin being raised, three parts. The first The parts of the skin. is an infinite number of *papillæ pyramidales*; they are the ends of all the nerves of the skin, each of which are enclosed in two or three covers of a pyramidal figure, and these covers are each above another. They may be easily seen and separated in the skin of an elephant, and in the skin of the feet of several other animals. Between these papillæ are an infinite number of holes, which are the orifices of the excretory vessels of the miliary glands underneath. About the papillæ is spread a mucous substance, which, because it is pierced by them, and consequently full of little holes, is called by Malpighius the *corpus reticulare*; its use is, to keep the extremities of the nerves soft and moist, and sensible of the slightest touches. The second part is a web of nervous fibres, and other vessels differently interwoven; and it is the *parenchyma*, or that part of the skin that the parchment is made of. The third part is an infinite number of miliary glands, about which there is much fat, they ly under the other two parts; they separate the matter of sweat and insensible transpiration. Each gland receives a nerve and artery, and sends out a vein and excretory vessel, which last passes through the other two parts to the *cuticula*, for the discharging the body of this matter, and for the moistening the *cuticula* and

and the *papillæ pyramidalis*, that they may not dry, which would very much hurt the sense of touching. Upon the surface of the skin there are many parallel lines, which are cut by as many parallel ones. These intersections make spaces of a rhomboidal figure; and out of each angle, for the greatest part, grows a hair, shorter or longer as nature requires, in the several parts of the body; but in the palm of the hand, where there are no hairs, these lines do not intersect one another, and on the ends of the fingers they are spiral.

The thickness of the skin,

The skin is six times thicker than the scarf skin; and in the sole of the foot it is much thicker than in the face, hands, and other parts. In the summer it is softer, because the pores are wider. In the winter it is more compact and hard, because the pores are more close; therefore the hairs of beasts stick faster, and furs made of them are better in that season. In some the skin is white, in others black and tawny; which probably comes from the different colours of the mucosity which covers the *parenchyma* of the skin; for the fibres of the skin in all are white, and there is little or no difference in the colour of different bloods.

The use of the skin,

The skin is not only a covering in which all the parts of the body are wrapt up, but in it also nature has placed the organs of the sense of feeling, so that not the least thing hurtful can assault us without our knowledge. And as it preserves us from external offences, so it relieves us of noxious and superfluous internal humours; its glands being the e-

munctories

municatories of the whole body, thro' which not only the peccant humours pass, but likewise the greatest part of the liquors which we drink ; which having part of their office in conveying the aliments into the blood, are, in the next place, to dissolve the saline and terrestrial particles, to be carried off through the glands of the skin and kidneys.

Now the sum of all these particles strained through the cuticular glands, is by Sanctorius reckoned to amount to about fifty ounces a day in Italy: so that suppose a man's body to weigh 160 pounds, then in 51 days we perspire a quantity equal to the weight of the whole body. And from the consideration of this and other evacuations, our bodies are said to be renewed and changed in some stated times; but that the vessels, or solid parts of the body, do constantly decay, waste, and evaporate, does not at all, to me, seem probable; nor, if they do, is it possible to determine in what time there is a total change: and I am more apt to think, that the fluids only consume; of which, though several pounds are daily lost, yet it is not from thence certain when the old stock is spent, and the vessels filled with new juices; for, besides that the true quantity of blood in the body is not certainly known, we can never be sure whether they be new or old juices; or a mixture of both, which are constantly flying off; and if a mixture, which is most probable, in what proportion they are mixed, which must necessarily be known, in order to determine when the old mass is entirely evacuated. But that some of our native blood

B

does

does remain in the body, even to the last stages of life, seems credible from hence, that some have fallen into the small pox at 80 and 90 years of age.

S E C T. V.

Of the Hair.

THE hair may justly be reckoned one of the common teguments of the body, not only for its use, but also because it is to be found upon all the parts of the body, except the soles of the feet, and palms of the hands. It grows longest upon the head, beard, in the arm-pits, and about the privities. When we examine the hairs with a microscope, we find that they have each a round bulbous root, which lies pretty deep in the skin, and which draws their nourishment from the surrounding humours; that each hair consists of five or six others wrapt up in a common tegument or tube. They grow as the nails do, each part near the root thrusting forward that which is immediately above it, and not by any liquor running along the hair in tubes, as plants grow. Their different colours depend much upon the different temperaments and quality of the humours that nourish them. The use of the hairs is for a covering and ornament to the body. Whatever the efficient cause may be why a man has a beard, and a woman none, it is certain, the final cause is, for the distinguishing the male from the female sex,

fex, which otherwise would hardly be known, if both were dressed in the same habit.

S E C T. VI.

Of the Fat.

UNderneath the skin there lies a membrane called the *membrana adiposa*, which, by the help of a microscope, appears to be composed of an infinite number of fine transparent vesicles, or bladders, into which the blood-vessels that are spread upon them deposite the oily and sulphureous part of the blood, which in these membranous cells we call fat.

Malpighius mentions a net of small vessels, which he calls *ductus adiposi*, because they are full of fat; these he supposes bring the fat into the cells; but he could never discover from whence they take their rise. There are also a number of little glands, which are accompanied with lymphatic vessels, which carry back any serosity that is superfluous. The vessels of the fat.

The fat is to be found immediately under the skin, in all the parts of the body, except in the forehead, eye-lids, lips, upper-part of the ear, yard, and *scrotum*. In some the vesicles of the *membrana adiposa* are so full, that the fat is an inch or more thick; and in others they are almost flat, containing little or no fat. There are two sorts of fat, one white, or rather yellow, soft and lax, which is easily melted, called *pinguedo*; Two sorts of fat.

another white, firm, brittle, and which is not easily melted, called *sebum*, or tallow. Some reckon the marrow of the bones for a third sort of fat.

The use of
the fat.

The chief use of the fat is to blunt and sweeten the too great sharpness and acrimony of the salts which are in the blood. It serves also to moisten and supple the parts, for facilitating their motion; to fill up the interstices of the parts, that the skin may be smooth and beautiful; to defend the body against external cold; and, in fine, to hinder too great a dissipation of the spirits.

S E C T. VII.

Of the Membrana Adiposa, Carnosa Communis, and Propria Musculorum.

What a
membrane
is.

A Membrane is a web of several sorts of fibres interwoven, for the covering and wrapping up of some parts. Their membranous fibres give them an elasticity, whereby they can contract and closely clasp the parts they contain; and their nervous fibres give them an exquisite sense, which is the cause of their contraction; therefore they can scarcely suffer the sharpness of medicines, and they are difficultly united when wounded. In their texture, they are a number of small glands, which separate an humour fit for moistening the parts which they contain. By reason of the thickness and transparency of the membranes, the ramification of the blood-vessels is more apparently to be seen in them, than
in

Of the Membrana Adiposa, &c.

in any other part of the body : here the innumerable divisions, windings and turnings, serpentine progressions, and frequent inosculations, not only of veins and arteries together, but also of veins with veins, and arteries with arteries, make a most agreeable embroidery and delicate net-work, covering the whole membrane. Nor is nature always constant to the same disposition, but delights in variety here, as well as in the disposition of the branches and leaves of plants and trees. Those that cover the solid parts, are properly called membranes ; and they have their particular names, as the *peritonæum*, which wraps up all that is contained in the *abdomen* ; the *pleura*, that which is in the *thorax* ; the *periosteum*, the bones ; and the *pericardium*, the heart. Those which form the coats of vessels, and which contain the humours, as those of the veins, arteries, stomach, bladder, intestines, testicles, &c. are called tunics, or coats : and those which cover and embrace the brain, as the *dura* and the *pia mater* are called *meninges*. Of all those kinds of membranes, some are thin, and some thick ; and the same membrane is thick in some places, and thin in other places, as in the *membrana adiposa*, which is thicker in the neck than in any other part of the body. The use of the membranes is to cover and wrap up the parts ; to strengthen them ; to save them from external injuries ; to preserve the natural heat ; to join one part to another ; to sustain small vessels, and the nerves which run through their duplicatures ; to stop the returning of

A distinction of membranes.

The use of the membranes.

the humours in their vessels, as the valves stop the returning of the blood in the veins and heart; of the chyle in the lacteals and thoracick duct; and of the *lymphæ*, in the lymphatic vessels.

The mem-
brana adipo-
sa and car-
nosa.

By the *membrana adiposa*, is most commonly understood that part of it only which lies next the flesh, and which contains but little fat in its cells; and therefore appearing more membranous than the rest, is said to be the basis of the *cellulæ adiposæ*. And even some part of this hath been taken by anatomists for the *membrana carnosa*, upon the account of its redness; for here the blood-vessels ly very thick, the vesicles not being distended with fat.

Of the
membrana
communis
musculo-
rum.

Anatomists do generally asserts, that there is a *membrana communis musculorum*, being led into that mistake by the *aponurosis* of several muscles; whereas, upon stricter observation, there is no such thing to be found.

Of the
membrana
propria
musculo-
rum.

The *membrana propria musculorum* is that which covers immediately all and every one of the fibres of a muscle, and is closely tack-
ed to them. There is another called *mem-*

Of the
membrana
communis
vasculorum.

brana communis vasculorum, which is a thin membrane, and accompanies almost all the vessels of the body. All these membranes receive veins, arteries, and nerves from the parts which are nearest to them.

C H A P. II.

Of the Lower Belly.

S E C T. I.

Of the Muscles in general.

A Muscle is a bundle of fleshy and often tendinous fibres, of which all in the same plane are parallel to one another, and they are all inclosed by one proper membrane. The fleshy fibres compose that part which is called the body or belly of the muscle; they are red, lax, and spongy, containing a number of small cavities; they are tied together by a number of small and short threads, which go from fibre to fibre, called membranous fibres. The tendinous fibres compose the two extremities; they are called head and tail, or the two tendons of the muscle; they are white, hard, compact, and closely bound together, which makes them less than the body of the muscles. In every tendon there are as many tendinous fibres, as there are fleshy fibres in the body of the muscle; so that every fleshy fibre answers at both ends to a tendinous fibre, to which they are always joined obliquely, making equal and alternative angles.

Muscles are either simple or composed; the simple have all their fibres parallel, and in the same direction; the composed have the

Of the Muscles in general.

the fleshy fibres of several planes crossing one another, or of different directions; and they may be divided into as many simple muscles as there are planes, whose fibres have different directions. Each plan resembles a *rhomboides*, or lozenge. The strength of a muscle consists in the number of its fibres. The tendons are sometimes double and triple, as the *biceps* and *triceps*. Sometimes several muscles join in one tendon, as the *tendo Achillis*. Sometimes one muscle has two bellies, as the *digastricus*.

We find also muscles without tendons, as the *quadratus* of the fore-arm, and several of the face, tongue, and lower jaw; and they are only inserted into the *periosteum*: Whereas those that have tendons are inserted into the body of the bone. There are others which have only tendons at one end, as may be seen in the *myology*. This makes me suspect that tendons are only for the conveniency of having a great number of fibres inserted about a small bone. Those who would have a more particular description of a muscle, may consult Steno and Borelli.

Each muscle, and every fibre in a muscle, has nerves, veins, and arteries, either of which being tied, deprives the muscle of the power of contracting; but the stoppage being removed, they contract again, and contracting swell; so that the action of the muscles is performed by the rarefaction of the blood and spirits distending the cavities of the fibres.

This rarefaction of the blood and spirits, we suppose to be performed after this manner.

Of the Muscles in general.

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ner. The blood is full of globules of air strongly compressed by the surrounding particles of blood attracting one another, which therefore form a globule or shell of blood, in the middle of which is a small globule of air, whose force of expansion will be always proportional to the force by which it is compressed. These globules continually circulating through the cavities of the muscular fibres, are mixed with the animal spirits, which, at our will and direction, drop from the nerves into the cells of the fibres, and attracting the particles of the blood more strongly than they do one another, give the inclosed air an opportunity of expanding itself, and consequently of swelling the vesicle; and each vesicle swelling at the same time, the whole fibre must be shortened; and the shortening of all the fibres is the contraction of the muscle.

Though the contraction of the fibres be considerable, yet the swelling is scarcely sensible, by reason of the smallness of the cavities of the fibres. For each fibre resembles a string of bladders, each of which being blown up singly, will raise a weight to some determined height; and if the whole string of similar and equal bladders be blown up together, the space through which the weight will rise will be proportional to the number of bladders, or length of the string or fibre of the muscle. Now, though the swelling of a large bladder required to raise a weight to some considerable height, must be very great; yet several small bladders will do the same thing with a force and swelling less

Of the Muscles of the Lower Belly.

less in any given proportion. For suppose a bladder of a determined bigness can raise a weight a foot, a hundred bladders, whose diameters are each one hundred part of the former, being blown up, will raise the weight to the same height; but the force of inflation, and the swelling of all put together, will be a thousand times less than in the large one. And thus we see how mechanically the structure of the fibres contributes to the contraction of the muscles, with a very inconsiderable force, and a swelling almost imperceptible.

S E C T. II.

Of the Muscles of the Lower Belly.

*Obliquus
externus.*

HAVING raised the skin and fat, the muscles of the lower belly appear, which are five pair in number; the first of which that presents itself, is the *obliquus externus* or *descendens*; it takes its origination from the two last true, and the five false ribs, by five or six digitations, the four uppermost of which ly between the teeth of the *serratus anticus major*; its fibres descending obliquely, are inserted all along the *linea alba* under the *musculi recti*, to the upper and fore-part of the spine of the *ilium*, and to the fore-part of the *os pubis*. It has a large *aponeurosis*, or tendinous expansion, which covers both itself and the *musculi recti*. The *linea alba* is a line which reaches betwixt the *cartilago-xiphoides* and the *os pubis*, made by the

the union of the tendons of the oblique and transverse muscles, dividing the *abdomen* in two in the middle. This muscle receives a twig of a nerve from the intercostals at each of its digitations.

The second pair is the *obliquus ascendens* or *Obliquus internus*, whose fibres are disposed in a contrary manner, crossing the former obliquely; they arise with a large and fleshy beginning from the circumference of the *ilium*, from the *os pubis*. Above, they are fixed to the cartilaginous part of the false ribs, and they are inserted all along the *linea alba*.

The third pair is the *transversalis*: it lies under the two former; it arises from the *cartilago-xiphoides*, from the extremities of the false ribs, from the transverse *apophyses* of the *vertebrae* of the loins; it is fixed to the inner side of the spine of the *ilium*, and is inserted in the *os pubis*, and *linea alba*.

These three muscles unite their tendons as they approach the *linea alba*; they are pierced in the middle of the *linea alba*, for the passage of the umbilical vessels. They are also pierced above the *os pubis*, for the passage of the spermatick vessels in men, and the round ligaments of the womb in women. These holes are not opposed to one another; that which is in the transversal is highest, that in the *obliquus ascendens* is a little lower, and that in the *obliquus descendens* lowest. It is this last which is only cut in the operation of the *bubonocoele*; it has a fine and thin membrane that closes exactly its ring or hole through which the vessels pass.

The

Of the Muscles of the Lower Belly.

Rectus.

The fourth pair, which is covered with the *aponeurosis* of the *obliqui*, is the *musculus rectus*; it arises from the *sternum*, the extremity of the last two true ribs, and goes straight down the fore-part of the *abdomen* to be inserted in the *os pubis*. This muscle has three or four innervations, or rather tendinous coarctations of its fleshy fibres, which divide the belly of this muscle, as it were, into so many distinct muscles. It has veins and arteries, which creep in its inside, from the mamillary and the epigastric vessels, which communicate, that the blood may return by the mamillary veins, when the passage is stopt by the epigastrick, which are compressed in women big with child.

Pyramidalis.

The fifth part is the *pyramidalis*, so called because of their figure; they rise with a fleshy beginning, from the outer and upper part of the *os pubis*, and growing narrower and narrower, are inserted in the *linea alba*, sometimes near to the navel. Sometimes one, and sometimes both of these muscles are wanting.

The use of these muscles.

The use of these muscles is, to compress all the parts contained in the *abdomen*; by which compression, the motion of the several fluids through their vessels in general, is promoted, and particularly that of the chyle through the lacteal vessels; the stomach discharges itself in vomiting of what is offensive to it, and the *rectum*, of the excrements it contains; in expiration the ascension of the midriff, and descension of the ribs by the oblique muscles are facilitated; the distention of the intestines beyond their natural

tone is prevented: For, without this compression upon the intestines, the air in their cavity being rarified by the heat of the body, must have stretched them to such a degree as to have stopt both their peristaltick motion, and the circulation of the blood in their vessels. By their contraction the trunk of the body is bent forwards and by the contrivance of their fibres decussating one another, every point of the lower belly is sufficiently compressed, so as that the intestines can slip no where from the compression.

S E C T. III.

Of the Peritonæum.

IMmediately under the muscles of the lower belly appears the *peritonæum*. Its description. Is is a thin and soft membrane, which incloses all the bowels contained in the lower belly, covering all the inside of its cavity. Its external superficies is unequal where it adheres to the transverse muscles. The internal is very smooth and polished. It has a number of small glands that separate a liquor which supples the intestines, and facilitates their motion. When these glands are obstructed, the *peritonæum* grows thick, as may be seen in several dropfies.

The upper part of this membrane covers the midriff, to which it closely adheres; the fore part of it sticks to the transverse muscles and *linea alba*; the lower part of it to the *os pubis*; and the back part of it

to the *os sacrum*, and *vertebræ* of the loins. It is a double membrane, and contains in its duplicatures the umbilical vessels, the bladder, the ureters, the kidneys, and the spermatic vessels, to all which it gives a membrane, as also to the liver, spleen, stomach, intestines, and womb.

Its productions.

Its external *lamina* has two productions, like to two sheaths, which pass through the rings of the oblique and transverse muscles in the groin, for the passage of the spermatic vessels in men, and for the round ligaments of the womb in women. These productions being come to the testicles in men, dilate and form the *tunica vaginalis*. The internal *lamina*, which is here very thin, having accompanied the external productions a little way, cleaves close to the spermatic vessels, and round ligaments of the womb.

Its vessels.

The *peritonæum* has veins and arteries from the *phrenicæ*, from the mammillary, the epigastric, and often from the spermatics. Its nerves are of those which are distributed in the muscles of the *abdomen*. It has likewise a few lymphatics, which discharge themselves into the iliac glands. By the elasticity of its fibres, it easily dilates and contracts in respiration and conception. If it breaks, it causes a rupture either in the groin or navel. Its use is to contain the bowels of the *abdomen*, and to give each of them an outer coat.

S E C T. IV.

Of the Omentum.

WHEN the *peritonæum* is cut, as is usual, and the cavity of the *abdomen* laid open, the *omentum*, or cawl, presents itself first to view. This membrane, which is like a wide and empty bag, covers the greatest part of the guts. Its mouth is tied in the right side to the hollow of the liver, in the left to the spleen, backwards to the back part of the *duodenum*, and that part of the *colon* which lies under the stomach, and forwards to the bottom of the stomach and *pylorus*. Its bottom is loose, and being tied to no part, but floating upon the surface of the guts, below the navel, was the reason why the cawl was by the Greeks called *ἐπίπλουν*. Sometimes it descends as low as the *os pubis*, within the productions of the *peritonæum*, causing an *epiplocele*.

Its description.

Now the cawl is a most delicate and fine double membrane, interlarded, for the most part, with a great deal of fat, which lines each side of its blood-vessels. These are veins from the *portæ*, called *gastroepiplois dextra et sinistra*, arteries from the *cœliaca*. The intercostal nerve, and the *par vagum*, send it several twigs of nerves. All these vessels, with some small glands accompanying one another, spread their branches very curiously upon the cawl, and even to the minutest twig; they run between two lines of fat, which are bigger, or smaller, according

Of the Oesophagus.

ing to the weight of the cawl. It has been sometimes found to weigh five pounds but ordinarily it does not much exceed half a pound. Where there are no vessels, the membrane of the cawl is very fine and transparent.

Its use.

They give several uses to the cawl, as to cover the bottom of the stomach and the intestines, that, by cherishing their heat, it may promote digestion, and help the concoction of the chyle; to strengthen and sustain the vessels which go from the spleen to the stomach, intestines, pancreas, and liver; to keep a store of the fat, that it may be received by the veins and lymphatics, for the use we have spoken of; to grease the superficies of the guts, for facilitating their peristaltick motion.

S E C T. V.

Of the Oesophagus.

THough the *Oesophagus* and *ductus thoracicus* lie not in the lower belly; yet, that I may at once shew the entire passage of the aliments from the mouth to the blood, I shall describe them both in this chapter.

Its situation.

The *Oesophagus*, or gullet, is a long, large, and round canal, which descends from the mouth, lying all along betwixt the windpipe and the joints of the neck and back, to the fifth joint of the back, where it turns a little to the right, and gives way to the *aorta descendens*, and both run by one another,

Of the Oesophagus.

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other, till at the ninth the *oesophagus* turns again to the left; climbs above the *aorta*, and, descending above it, it pierces the midriff, and is continued to the left orifice of the stomach.

The gullet is composed of three cotes. Its coats. The first and outermost is only a common membranous integument, which seems to be a continuation of the *pleura*.

The second is thick and fleshy, and consists of two orders of muscular fibres, longitudinal and circular, the first covering the last; these thrust the aliments down into the stomach. In brutes, because the situation of their neck conduces little to the descent of the aliments, therefore these fibres run in two close spiral lines which cross one another: but in men, whose position is erect, the very gravity of the aliments helps their descent.

The third and last line is in the cavity of the gullet. It is composed of white and slender fibres diversly interwoven. At its upper end it is continued to the membrane that covers the mouth and lips; therefore, in vomiting, these parts are affected. Its lower end covers the left orifice of the stomach two or three fingers breadth. The surface of this membrane is besmeared with a soft and slimy substance, which probably comes from some small glands that ly between this coat and the second.

The upper end of the gullet is called *pharynx*. It has two pair of muscles for its motion. The first is the *stylo-pharyngæus*. The muscles of the pharynx. This is a small and round muscle, which arises

Of the Oesophagus.

rises fleshy from the root of the *processus styloides*, and descending obliquely, it is inserted into the sides of the *pharynx*. When this muscle acteth, it pulleth up and dilateth the *pharynx*, in deglutition.

The second is the *oesophagus*. Its fibres have several directions; its superior fibres arise from the *processus pterigoidæus* of the *os sphænoides*, and from the *cornua* of the *os hyoides*, and run obliquely to the back part of the *pharynx*. The fibres which are below these arise from the sides of the *cartilago scutiformis*, and run transversely to the middle of the back part of the *pharynx*, where both superior and inferior fibres from both sides unite and form a tendinous line. When this muscle acts, it draws the back part of the *pharynx* to its fore part; by which it not only straitens it for the depressing of the aliment, but it compresses also the *tonsillæ*, which send out their liquor which lubricates the aliment, whereby it glides the more easily down into the stomach.

Its glands.

There are two lymphatick or verficular glands which are tied on the back side of the gullet about the fifth *vertebra* of the back, by the branches of nerves which come from the eighth pair. These two glands are like two kidney-beans tied together; they receive veins and arteries from the *coronariæ*, and they have lymphatick vessels which discharge themselves into the thoracick duct. Bartholine remarks, that these glands sometimes swell so big, as to hinder the descent of the aliments into the stomach.

The gullet at its upper end receives an artery

artery from the *aorta*, and it sends a vein to the *azygos*: at its lower end it has an artery from the *cœliaca*, and it gives a vein to the *coronaria* of the stomach. Its nerves are from the eighth pair.

The use of the gullet is to carry the meat Its use. from the mouth into the stomach, by means of the muscles of the *pharynx*, and fleshy fibres of the *gula*, which perform its peristaltick motion.

S E C T. VI.

Of the Stomach.

THE stomach, *ventriculus*, or γαστήρ, Its situa-
 lies immediately under the midriff; tion.
 the liver covers a part of its right side,
 the spleen touches it on the left side, and
 the *colon* at its bottom, to which also the
 cawl is tied. Its figure resembles a bag- Its figure.
 pipe, being long, large, wide, and pretty
 round at the bottom, but shorter, and less
 convex on its upper part, where it has two
 orifices, one at each end, which are some-
 what higher than the middle between them.
 The left orifice is called *napoia*; to it the oe- Its orifice.
sophagus is joined. By this orifice the ali-
 ments enter the stomach, where, being di-
 gested, they ascend obliquely to the *pylorus*,
 or right orifice, which is united to the first
 of the intestines. At this orifice the tuni-
 cles of the stomach are much thicker than
 they are any where else, and the inmost has
 a thick and strong duplicature in form of a
 ring,

ring, which serves as a valve to the *pylorus* when it contracts and shuts.

Its coats.

The stomach is made of four membranes or coats. The first and inmost is made of short fibres which stand perpendicularly upon the fibres of the next coat; they are to be seen plainly towards the *pylorus*. When the stomach is distended with meat, these fibres become thick and short. Whilst they endeavour to restore themselves by their natural elasticity, they contract the cavity of the stomach, for the attrition and expulsion of the aliments. This coat is much larger than the rest, seeing it is full of plaits and wrinkles, and chiefly about the *pylorus*. These plaits retard the Chyle, that it run not out of the stomach before it be sufficiently digested. In this coat there are also a great number of small glands, which separate a liquor which besmears all the cavity of the stomach, and helps the concoction of the aliments; therefore this coat is called *tunica glandulosa*.

The second is much finer and thinner; it is altogether nervous; it is of an exquisite sense, and it is called *nervosa*.

The third is muscular, being made of strait and circular fibres; the strait run upon the upper part of the stomach, between its superior and inferior orifices; and the circular run obliquely from the upper part of the stomach to the bottom. Of these the innermost descend towards the right side, and the outermost towards the left; so that by their action both ends of the stomach are drawn towards its middle, and the whole is equally

equally contracted; by their contraction and continual motion, the attrition and digestion of the aliments is in a great measure performed.

The fourth tunicle is common, it comes from the *peritonæum*.

The stomach sends veins to the *porta*, viz. Its vessels, the *gastrica*, *pylorica*, and *vas breve*, and branches to the *gastro-epiplois dextra et sinistra* which are accompanied with branches of the *arteria cœliaca*, all which ly immediately under the fourth coat of the stomach.

The eighth pair of nerves, or *par vagum*, gives two considerable branches to the stomach, which descending by the sides of the gullet, divide each into two branches, the external and internal. The two external branches unite in one, and the internal do so likewise, both which piercing the midriff, form, by a great number of small twigs, upon the upper orifice of the stomach, a *plexus*; and then the internal branch spreads itself down to the bottom of the stomach; and the external branch spreads itself upon the inside, about the upper orifice of the stomach. This great number of nerves which is about the upper orifice, renders it very sensible; and from them also proceeds the great sympathy betwixt the stomach, head, and heart; upon which account Val. Helmont thought, that the soul had its seat in the upper orifice of the stomach.

The *plexus nervosi* of the *hypochondria* and *mesenterium* give several branches to the bottom of the stomach, therefore, in hysterick

rick and hypochondriack passions, the stomach is also affected.

Its use.

The use of the stomach is digestion, which is the dissolution or separation of the aliments into such minute parts as are fit to enter our lacteal vessels, and circulate with the mass of blood : or it is the simple breaking of the cohesion of all the little *molecules* which compose the substances we feed upon. Now the principal agents employed in this action are first, the *saliva*, the *succus* of the glands in the stomach, and the liquors we drink ; whose chief property is to soften the aliments, as they are fluids, which easily enter the pores of moist bodies, and swelling them, break their most intimate cohesions. And how prodigious a force fluids acting in such a manner have, we may learn from the force that water, with which a rope is wetted, has to raise a weight fastened to, and sustained at one end of it : and this force is much augmented by the *impetus* which the heat of the stomach gives to the particles of the fluids ; nor does this heat promote digestion only thus, but likewise by rarifying the air contained in the pores of our food, which bursts its parts asunder. And therefore such liquors as are most fluid, or whose particles have the least viscosity, are most proper for digestion ; because they can the more easily insinuate themselves into the pores of our aliments ; and, of all other, waters seem the fittest for this use ; for though some spiritous liquors may as easily penetrate the substances we feed upon, yet they have another property, by which they

they hurt rather than help digestions ; and that is, their particles have a strong attractive force, by which, when imbibed into the substance of our victuals, they draw their parts nearer to one another, contract and harden, instead of swelling and dissolving them. It is by this property that they preserve animal and vegetable substances from corrupting ; not but that we find they sometimes help digestion, yet not by dissolving the aliments, but as they irritate and excite the coats of the stomach to a stronger contraction ; and therefore, when they are duly diluted, they may be not only useful but requisite. But certainly strong liquors alone are most unfit for digestion, especially such as are likewise viscid ; and what sad effects they have upon the stomach itself, they are truly sensible, who, by a long use of them, have lost their appetite, hardly to be restored without the drinking of waters, which seldom fail of procuring a good appetite and strong digestion. When the aliments are thus prepared, their parts are soon separated from one another, and dissolved into a fluid with the liquors in the stomach, by the continual motion of its sides, whose absolute power is, by that great improver of the true theory of physick, the learned Pitcairne, demonstrated to be equal to the pressure of 117088 pound weight : to which if we add the absolute force of the *diaphragma*, and muscles of the *abdomen*, which likewise conduce to digestion, the sum will amount to 250734 pound weight. These two actions we see more clearly in birds,

birds, because they are performed in two stomachs. In the first, the corn is only swelled and softened by the liquor of its glands, but broken and dissolved in the second, which is composed of very strong muscles, because those of the *abdomen* and *diaphragma* are weak, neither do they act upon the stomach, as in men.

S E C T. VII.

Of the Intestines and Mesentery.

What the
guts are.

WHEN the aliments are sufficiently dissolved in the stomach, they are by its muscular fibres thrust out into the *intestines*, or guts. Now the *intestines* are a long and large pipe, which by several circumvolutions and turnings, reaches from the *pylorus* to the *anus*. They are knit all along to the edge of a membrane called the *mesentery*, and are six times as long as the body to which they appertain; that the chyle which escapes the lacteals of one part of the guts, may be taken up by those in the next.

Their coats.

They are composed of three coats, of which the first and inmost is made up of short fibres bound together by fine blood-vessels, and disposed as those of the stomach; for the length of the fibre is the thickness of the coat. Leeuwenhock first observed these fibres with his glasses: but, if you carefully inject the mesenterick artery with warm water, they will separate from one another, and become visible to the naked eye. They

act

act after the same manner as those of the inner membrane of the stomach, for the contracting of the cavity of the guts. This coat being much longer than the others, lies in wrinkles or plaits, called *valvulae conniventes*, which in the small guts form larger segments of circles, and are closer to one another, than in the great guts, where they are broader, and seem to be chiefly designed to sustain the weight of the *fæces*; whereas the others, by retarding the motion of the chyle, and by directly opposing the mouths of the lacteal vessels (which are in the upper side of the valves) to its passage, give it a more favourable opportunity, and better chance for entering, than otherwise it would have. This coat has likewise a great number of little glands, which in the small guts lie in clusters every where but where they are knit to the mesentery: in the great guts they are much fewer, and are placed at some distance from one another. The use of these glands is disputed: some think that they separate the slime which besmears the inside of the intestines, to defend them against the acrimony of the bile; but this more probably comes from some remainder of the chyle. Others take them for the mouths of the lacteal vessels: but there are many lacteals where there are no glands. If we consider, that they are most chiefly placed where the lacteals are most numerous, we cannot but think that they separate a liquor for diluting of the thick chyle, that it may the more easily enter the narrow orifices of the lacteal veins.

D

The

Of the Intestines and Mesentery.

The second coat is made up of two orders of muscular fibres; of which one runs straight, according to the length of the guts; the other goes round, and its fibres are more reasonably thought to describe a spiral line, than circles. For if, as some imagine, these fibres were not spiral, but circular, it is not easy to conceive, how that constant and uniform vermicular, or wave-like motion of the intestines, could be transmitted from part to part by fibres, which had no communication with one another, but which, having once surrounded the gut, are at both ends fixed to the edge of the mesentery; whereas now, by the successive motion of the parts of these two orders of fibres, the guts are in a continual undulation, which is called their peristaltick motion.

The third and external coat is common, it cometh from the *peritonæum*.

The division
of the guts.

Of the duo-
denum.

Though the intestines be one continued pipe, yet anatomists divide it into six parts, three thin and small, and three thick and great. The three thin and small are, the *duodenum*, *jejunum*, and *ilium*. The *duodenum* is the first part of the intestines; it is about twelve fingers breadth long; it is continued to the *pylorus*, from which, turning downwards, it runs under the stomach, immediately above the *vertebræ*, towards the left side, and ends at the first of the windings, under the *colon*. At its lower end there are two canals, which open in its cavity; one comes from the liver and gall-bladder, called *ductus communis choledochus*; the other from the *pancreas*, called *ductus pancreaticus*.

pancreaticus. The first brings the bile; the second the *succus pancreaticus* into this intestine. It differs from the other two in this, that its passage is straiter, and its coat thicker.

The second is the *jejunum*; it begins at the first winding of the guts under the *colon*, where the *duodenum* ended; and making several turnings and windings from the left side to the right, and from the right again to the left, it is continued to the *ilium*, filling all the upper part of the umbilical region, being about 12 or 13 hands breadth long. It differs from the *ilium* only in this, that it hath some more *venæ lacteæ*, into which the chyle passing, it is found always more empty, therefore it is called *jejunum*: and the folds of its inner coat are nearer to one another, and in greater number, than in the *ilium*. Of the jejunum.

The third and last of the small guts is the *ilium*, it is about 21 hands breadth long; it begins where the *jejunum* ends, and making several turnings and windings, it fills all the lower part of the umbilical region, and all the space betwixt the *ilia*, and is continued to the beginning of the *colon* at right angles; its passage is a little narrower than that of the *jejunum*, and its coats seem somewhat thinner. Of the ilium.

This intestine, because of its situation, falls easily down into the *scrotum*, by the productions of the *peritonæum*. In it also happens the *volvulus*, when one part of this gut enters the cavity of the part immediately above or below.

Of the Intestines and Mesentery.

The thick and great guts are, *cæcum*, *colon*, and *rectum*.

Of the *cæcum*,

The *cæcum*, although small, yet is taken for the first of the great guts; but the ancients, who made this division of the guts, called the beginning of the *colon* the *cæcum*; and what is now called *cæcum*, they called *appendix cæci*. It is four or five fingers breadth long, and about the bigness of a swan's quill. It is called *cæcum*, because it is open only at one end, by which it is tied to the beginning of the *colon*, to which it seems to be an appendage; so that the excrements go in and come out at the same orifice. Its other end, which is shut, is not tied to the mesentery, but to the right kidney, by means of the *peritoneum*. Its use is yet unknown. Some take it for a second stomach, others for a receptacle of the excrement of the *fœtus*, in which it is always full, till after the birth. Others say it contains a ferment, and others the flatuosity of the intestines; and others, that it separates a liquor by some glands which are in its cavity; which liquor serves to harden the excrements as they pass through the *colon*.

Of the *colon*.

The *colon* is the greatest and widest of all the intestines, and about eight or nine hands breadths long. It begins where the *ilium* ends, in the cavity of the *os ilium* on the right side; from thence ascending by the kidney of the same side, it passes under the concave side of the liver, to which it is sometimes tied, as likewise to the gall-bladder, which tinges it yellow in that place; then it runs under the bottom of the stomach

Of the Intestines and Mesentery.

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mach to the spleen in the left side, to which it is also knit; from thence it turns down to the left kidney, and then passing in form of an S, it ends at the upper part of the *os sacrum* into the *rectum*.

At the beginning of this gut there is a valve formed by the production of the inmost coat of the intestines in this place; it hinders the excrements which are once fallen into the *colon* to return again to the *ilium*. It has a strong ligament, which running along its upper side from the *ilium* to the *rectum*, strengthens it against the weight of the excrements, and draws it together into cells, which, with the *valvulae conniventes*, retard the passage of the excrements, that we may not be obliged continually to go to stool. The fleshy fibres of its second coat are greater and stronger than those of the other intestines, because a greater strength was requisite to cause the excrements to ascend. The chief design of the *colon*'s surrounding the *abdomen*, and with the *rectum*, touching all the parts contained in it, seems to be, that by immediate fomentation with clysters, we might ease them of their maladies.

The *rectum* is the last of the intestines. ^{Of the} It is a hand's breadth and a half long: its ^{rectum.} cavity is about three fingers in diameter; its coats are thicker than those of the *colon*. It begins at the upper part of the *os sacrum*, where the *colon* ends, and going straight down, it is tied to the extremity of the *coccyx* by the *peritonæum* behind, and to the neck of the bladder in men, and in women to the neck of the womb before; from

thence comes the sympathy between these parts. There is very much fat about its external side, therefore it is called the fat gut. Its extremity forms the *anus*, into which there are three muscles inserted. The first is the *spincler ani*; this is a fleshy muscle, about four fingers broad, composed of circular fibres, which embrace the extremity of the *rectum*, for three fingers height, and which hang over it another fingers breadth; so that, in the operation for a *fistula in ano*, there is always an inch more of this muscle cut than there is of the *rectum*. It is connected forward to the *acceleratores urinæ* in men, and to the neck of the womb in women, and backwards to the *os coccygis*. Its use is to shut the passage of the *anus*, which the weight of the *faces* open.

Of the muscles of the rectum.

The other two muscles are the *levatores ani*; they arise from the internal and lateral side of the *os ischii*, and are inserted into the *spincler ani*. They draw the *anus* upwards.

- A palsy of the *spincler* causes an involuntary running of the excrements, and a palsy of the *levatores* causes a descent of the *anus*.

Now all these guts lying in a little space, are kept from entangling one another by the *mesentery*; which is a fat membrane, placed in the middle of the *abdomen*, almost of a circular figure, with a narrow production, to which the end of the *colon* and beginning of the *rectum* are tied. It is about four fingers breadth and an half in diameter; its circumference being full of plaits and foldings, is about three ells in length. The intestines, which are tied to this circumference, are

Of the mesentery.

are about eight or nine ells long ; so that to every inch of the circumference of the mesentery, there are three inches of the intestines fastened. The mesentery itself is strongly tied to the first three *vertebrae* of the loins. It is composed of three *laminae*; the inner, upon which the glands and fat ly, and the *veins* and *arteries* run, is its own proper membrane; and the other two, which cover each side of the proper membrane; come from the *peritoneum*.

Between the two external *laminae* of the mesentery run the branches of the *arteria* ^{Of the vessels of the guts.} *mesenterica superior* and *inferior*, which bring the blood to the *intestines* and the *venae meseraicae*, which, being branches of the *portae*, carry the blood back from the guts to the liver. Here all the large branches of both *arteries* and *veins*, communicating with one another, march directly to the guts, where, with the *nerves* from the *plexus mesentericus*, they divide into an infinite number of smaller branches, which spread themselves exceeding finely upon the coats of the *intestines*.

The *venae lacteae*, and lymphatic vessels, run likewise upon the mesentery, in which there are also several vesicular glands, the biggest of which, in the middle of the mesentery, is called *pancreas ascellii*. These glands receive the *lymph*a and *chyle* from the lacteal veins, of which next in order.

S E C T. VIII.

*Of the Laëteal Veins, Receptacle of the Chyle,
and Thoracick Duët.*

WHILST the groffer parts of the aliments are by the peristaltick motion of the guts, by the preffure of the midriff, and muscles of the lower belly, thrust out at the *anus*; the finer parts, or chyle, are by the same powers squeezed into the narrow orifices of the laëteal veins.

These are long and slender pipes, whose coats are so thin as to become invifible when they are not distended with chyle, or *lymphæ*. They arise from all the parts of the small guts by fine capillary tubes, which, as they run from the sides of the guts to the glands in the mesentery, unite and form larger branches; these are called *venæ lacteæ primi generis*. The mouths of these laëteals, which are open into the cavity of the guts, from whence they receive their chyle, are so small as not to be seen by the best microscope. It was necessary they should be smaller than the finest arteries in the body, that nothing might enter which might stop the circulation of the blood. The same extremity of the laëteals has likewise communication with the capillary arteries of the guts, by which they receive a *lymphæ*, which dilutes and propels the chyle forwards, and washes the laëteals and glands, that they may not fur, and be obstructed by the cyle's staying

staying in them upon fasting. The other extremity of the lacteals discharges the chyle into the vesicular cells of the glands dispersed up and down the mesentery: and from these arise other lacteals of a larger size, which carry the chyle immediately into the *receptaculum chyli*; they are called *lacteæ secundi generis*. The lacteal veins have valves at several distances, which hinder the chyle from returning back into the intestines.

Asellius, who first discovered the lacteal vessels, in the year 1622, and his followers, thought that they carried the chyle to the liver: till Pequet, in the year 1651, found out the *receptaculum chyli*, and *ductus thoracicus*; though they both were elegantly described by the learned and accurate anatomist * Bartholomæus Eustachius, many years before the discovery of the lacteal veins.

Of the receptaculum chyli.

The receptacle of the chyle is easily found in live bodies, but with a greater difficulty

* *Itaque in illis animantibus (scil. Equis,) ab hoc ipso insigni trunco sinistro iugali, qua posterior sedes radiæ venæ internæ jugularis spectat, magna quædam propago germinat, quæ præterquam quod in ejus origine ostiolum semicirculare habet, est etiam alba & aquei humoris plena; nec longe ab ortu in duas partes scinditur, paulo post rursus coeuntes in unam, quæ nullos ramos diffundens, juxta sinistrum vertebrarum latus, penetrato septo transverso, deorsum ad medium usque lumborum fertur: quo loco latior effecta, magnamque arteriam circumplexa, obscurissimum sinem, mihi que non bene perceptum obtinet. Barth. Eust. Antigræmmate xiii. de vena sine pari.*

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in those that are dead. It lies between the descending trunk of the great artery, and the *vertebræ* of the loins, and is biggest between the *cæliac* and *emulgent* arteries, surrounded by several vesicular glands, called *glandulæ lumbares*, which discharge their *lymphæ* into it. Their receptacle receives all the second order of lacteals, as well as all the lymphatick veins both of the legs, and of all the parts contained in the *abdomen*; so that indeed it seems to be only a bag (which will contain about an ounce of water) formed by the union of these vessels: the bottom of it contracts to the smallness of a lymphatic vessel; the middle is sometimes divided into two or three parts, and the upper part stretches itself out into a duct about the bigness of a goose-quill. This duct ascends into the *thorax*, behind the great artery; and, about the heart, it frequently divides into two or three branches, which immediately unite again into one; and, creeping all along the gullet, it marches to the left subclavian vein, where it opens at one or two orifices, which are covered with a semi-lunar valve, that the blood may pass over them, and the chyle run from underneath it, and mix with the blood in the veins. The *ductus thoracicus* has valves at several distances, which hinder the chyle that has once passed them, from falling back. It receives the lympheducts from the several parts in the chest, as it passes along to the subclavian vein. By its running up the left side, the chyle receives a new *impetus*, from the pulsation of the great artery; whereas,

whereas, on the right side, it must have ascended only by the pressure of the *diaphragma*, and muscles of the lower belly upon the receptacle, which it equally enjoys in its present situation.

S E C T. IX.

Of the Lymphatick Vessels.

HAVING frequent occasion to mention the lymphatick vessels, which have no particular source or origination, but which almost all send their *lymph*a to the receptacle of the chyle and thoracick duct, just now described; I shall therefore give a general description of them in this place.

The lympheducts are slender pellucid tubes, whose cavities are contracted at small and unequal distances, by two opposite semilunar valves, which permit a thin and transparent liquor to pass through them towards the heart, but which shut, like flood-gates, upon its returning. They arise in all parts of the body; but after what manner, I think, needs no great dispute; for, without doubt, all the liquors in the body (excepting the chyle) are separated from the blood in the fine capillary vessels, by a different pipe from the common channel in which the rest of the blood moves: but whether this pipe be long or short, whether it be visible or invisible, it is still a gland, whilst it suffers some parts of the blood to pass through it, denying a passage to others. Now the glands

Of the Lymphatick Vessels.

glands which separate the *lymp̃ha*, are of the smallest kind, being invifible to the fineſt microſcope; but their excretory ducts, the lymphatick veſſels, unite with one another, and grow larger as they approach the heart; yet they do not open into one common channel, as the veins do; for ſometimes we find two or three, or more lympheducts, running one by another, which only communicate by ſhort intermediate ducts, or which unite, and immediately divide again. In their progreſs they always touch at one or two conglobate or veſicular glands, into which they diſcharge themſelves of their *lymp̃ha*. Sometimes the whole lympheduct opens at ſeveral places into the gland, and ſometimes it ſends in only two or three branches, whiſt the main trunk paſſes over, and joins the lympheducts which ariſe from the oppoſite ſide of the glands, exporting again the *lymp̃ha* to their common receptacles. Now the glands of the *abdomen* which receive the lympheducts from all the parts which it contains, as likewise from the lower extremities, as the *glandulae inguinales, ſacræ, iliacæ, lumbares, meſentericæ, and hepaticæ*; all which ſend out new lympheducts, which pour out their *lymp̃ha* into the *receptaculum chyli*, as thoſe of the cheſt, head, and arms, do into the *ductus thoracicus*, jugular and ſubclavian veins. Theſe glands are round and ſmooth bodies, about the bigneſs of a hazel-nut, bigger or leſſer, according to the number of lympheducts they receive. Their ſubſtance conſiſts of membranes, which divide the whole bulk

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into little cells, which receive the *lymph*a from the lympheducts; and therefore they are improperly called glands, being they separate no liquor from the blood. It is true, their exporting lympheducts communicating with their arteries, do receive a *lymph*a from them; but this is done without the help of the conglobate glands, as the lacteal veins do with the capillary arteries of the guts; and the chief use of these vesicular bodies seems to be, that the flow-moving *lymph*a may receive a greater velocity from the elastick contraction of their membranous cells, as well as from the new *lymph*a immediately derived from the arteries.

If you examine the *lymph*a chymically, you will find that it contains a great deal of volatile but no fixed salt, some phlegm, some sulphur, and a little earth.

The use of the *lymph*a may be gathered from the consideration of the parts into which it discharges itself. That which comes from the head, neck, and arms, is thrown into the jugular and subclavian veins. All the lympheducts which the parts in the cavity of the *thorax* send out, empty themselves into the thoracick duct, and the *lymph*a from all the rest of the body flows to the receptacle of the chyle; so that there can be no doubt, but that its chief use is to dilute and perfect the chyle before it mixes with the blood. Now the whole *lymph*a, which is separated from the blood, being requisite for this use, it is plain, that there could be no glands in the *abdomen* appropriated

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ted for the separation of the whole *lymphæ*, but what must have had a very great share of the blood which passes through the *aorta*, in order to separate so great a quantity of *lymphæ*. But the liver and kidneys requiring likewise a great quantity of blood, and which could not be avoided, nature chose to separate the *lymphæ* from the blood, which goes to all the parts of the body, rather than appoint particular glands for it in the *abdomen*, which would have been more at hand, but which would have robbed the other parts of a large quantity of blood, and occasioned a very unequal distribution of it.

S E C T. X.

Of the Glands in general.

THE modern anatomists have reduced all the glands of the body to two sorts, viz. the *glandulæ conglobatæ*, and the *glandulæ conglomeratæ*.

The conglobate gland.

A conglobate gland is a little smooth body, wrapped up in a fine skin, by which it is separated from all other parts, only admitting an artery and nerve to pass in, and giving way to a vein and excretory canal to come out. Of this sort are the glands of the brain, the labial glands, and the *testes*.

The conglomerate gland.

A conglomerate gland is composed of many little conglobate glands all tied together, and wrapped up in one common tunicle, or membrane. Sometimes all their excretory ducts unite, and make one common pipe, through

through which the liquor of all of them runs. as the *pancreas* and the *parotides* do. Sometimes the ducts uniting, form several pipes, which only communicate with one another, by cross canals, and such are the *mammæ*. Others again have several pipes, without any communication with one another; of which sort are the *glandulæ lachrymales*, and *prostratæ*. And a fourth sort is, when each little gland has its own excretory duct, through which it transmits its liquor to a common basin, as the kidneys.

This much of the fabrick of the *glands*, we know from dissections: Their inward structure, and the manner by which they separate the several humours from the blood, good glasses and sound reasoning must discover. The ancients thought that the *glands* were cisterns which contained certain liquors, by which the blood being fermented, throw off the humours we find in the excretory ducts. But as these ferments must mix with the blood, so they must be exhausted and carried off by the blood into veins. And because all the liquors in the body are separated from the blood, there must therefore be another ferment to separate more: but this second ferment is liable to the same fate as the first; and therefore there must be an infinite series of ferments in the body, which is absurd. If it should be said that the ferments are not carried off with the blood, they must be stopped by the structure of the *glands*: but then we have a secretion without a ferment, which is the opinion of most of the moderns; some of which think

Of the Glands in general.

that the *glands* are tubes, whose orifices differing in figure, admit only bodies of similar figures to pass through them. But this opinion is demonstrably false; for beside that liquors are susceptible of all figures, and that bodies of any figure, and a lesser diameter than that of the gland, will pass through, and that even a body of a similar figure, and equal diameter with that of the orifice of the gland, may be presented innumerable ways, and not be able to pass through whilst there is only one way it can pass; I say, besides all these, it is easy to demonstrate, that all the vessels in the body are either conical or cylindrical, and consequently no difference in the figure of their orifices: for the pressure of a fluid being always perpendicular upon the sides of the vessel that contains it, and equal at equal heights of the fluid, if the sides are soft and yielding, they must be equally distended; that is to say, a section perpendicular to the *axis* of the vessel must be a circle, and consequently the vessel be either cylindrical or conical. This is agreeable to the observations and speculations of the nicest * anatomists, who tell us, that a gland is nothing but a convolution of small arteries, whose last branches are cylindrical, or, which is the same thing, part of any infinitely long cone. A gland therefore being nothing else but a branch of an artery, whose farthest extremity becomes the excretory duct of the gland, let us consider how such a structure can se-

* Nuck and Bellini.

parate from the blood only, some parts of it; and how different glands may separate different parts of the blood. First then, if such a fluid is to be drawn off, as consists of the smallest particles of the blood; let that orifice of the gland, which is inserted into the artery of which it is a branch, be so small as to admit only the smallest particles of the blood; then these, and these only, will enter this gland; and the fluid which passes out at the other extremity of the tube, or the excretory duct, must be such as is required. If the particles of the blood, which are of the next size or magnitude, are required to be separated, let the orifice of the gland be so big as to receive these second particles, but small enough to exclude all bigger particles; then these second particles, together with the first or smallest, will enter the gland: but because the liquor to be discerned, is to consist only of the second sort of particles, that is, the second sort of particles only are to flow out at the extremity of the tube, which is the excretory duct; therefore we are to suppose, that this gland, (which is only a branch of an artery, and differs in nothing from a common artery, but in the narrowness of its channel) has branches which are big enough to receive the smallest particles only, and carry them off into the vein; so that, as both sorts of particles move together along the gland, the smallest particles will pass off through its branches, and a fluid, consisting chiefly of the second sort of particles, will arrive at the excretory duct. Thus the number of

branches may be so great as to draw off most of the smallest particles, before the second sort of particles arrive at the excretory duct; so the liquor to be secreted, may consist of both these sorts of particles, mixed together in any proportion, according to the number of branches. If a fluid, consisting of a third sort of particles, larger than either of the former, is to be secreted, the orifice of the gland must be just big enough to admit such particles, and none bigger; and the branches of the gland must be small enough to exclude the biggest particles, and big enough to receive the lesser; and according as the number of branches is, either greater or smaller, the fluid which runs out at the excretory duct will consist either of the largest particles, or of all together mixed, in any proportion. Thus we see, how a liquor thicker than the blood may be strained off from the blood, if the orifice of the gland be so big as to admit particles of all sizes, and the branches so numerous as to draw off the thinner part, before the thicker arrives at the excretory duct.

After this manner, the several humours of the body may be separated by the glands from the blood, which must either be composed of so many humours as are separated from it, or else it must contain a few principles which mixed all together from the blood, and which variously combined from the different humours which are drained from it, as a few rays of light of different refrangibilities mixed all together, produce a
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white colour, but variously combined, exhibit all imaginable variety of colours.

It is not at all probable, that the blood, in which we discern but two distinct parts, should be composed of near thirty simple humours; for so many do the glands secrete from it. Nor is it agreeable to that simplicity which nature constantly affects in all her operations. The principles of all natural bodies are said by philosophers not to exceed the number five; and how prodigious is the variety that results from their different mixtures, and modifications? If we suppose likewise but five principles, or different particles in the blood, their combinations alone, without different modifications and proportions, will yield near as many different humours as are separated from the blood. Nor is this purely a supposition, but it is matter of fact, that urine, sweat, tears, spittle, and milk, are compound liquors, and that in each of them there are parts common to all of them. And if the composition of some of the other humours of the body is not so apparent, it does no more follow from thence that they are not compounded, than it does that the blood is not, because we do not perceive in it the several humours, which by the glands are separated from it. Being therefore the several humours are formed by the various combinations of a few particles which compose the blood, and that each humour is secreted by glands, placed for the most part in some one part of the body as the gall, which is separated no where but in the liver, and the urine in the kidneys; the particles of
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Of the Glands in general.

the blood must fall into such combinations as are fit to form gall at the liver, urine, at the kidneys, and so of the others; otherwise the glands could never separate from the blood such humours. And being all the humours are composed of a few different particles, the greater will be the number of particles combined to form bile; and the greater quantity of bile will be secreted, the fewer there are of all other combinations at the liver. Such combinations therefore as are fit to form the humours proper to pass through the glands, where these combinations are formed, being there only requisite, will be there most numerous; and all others being there less requisite, or useless, will be there less numerous: And therefore, where-ever the particles of the blood are most dissolved, there will be placed such glands as separate humours which consist of the most simple combinations, or of particles which do the most easily combine; and at the greatest distance from these, will be situated the glands which secrete humours consisting of the most compound combinations, or of particles which do the most slowly unite. And between these will be all other glands, nearer to either extreme, as they separate humours more or less combined, or compounded of particles which do more quickly or slowly combine together. By the thinness of the liquor in the *pericardium*, and of the urine which passes through the kidneys, the particles of the blood seem to be most dissolved at and about the heart. Here we not only find the effects of this dissolution

olution in the secretions, but likewise the cause of the force of the air in respiration breaking the globules of the blood; which force is demonstrable to exceed the pressure of 100 pound weight upon the surface of the lungs. Nor is it evident only from the cause and effects, that the blood is here most dissolved, but likewise from the methods which nature takes to prevent the effects of this dissolution, in some particular places at a little distance from the heart; for the bile and seed being thick humours, composed of particles which combine but slowly together, and it being requisite that they should be secreted where the liver and testicles are placed; nature has made use of particular contrivances, to give the particles, which were to form these humours, more time to combine than they could have had otherwise, being so near to the heart: for the formation of the bile, she has contrived the *vena portæ*, and the spleen; through the first the blood moves near 200 times slower, and through the last altogether as much, than otherwise it had done. And that the particles which form the seed might have time to combine, the orifices of the spermatick arteries are contracted, and they likewise arise from the *vena cava*, a little below the emulgent, at a great distance from the testicles, contrary to the common course of nature, by which means the blood is 150 times longer in going to the testicles than otherwise it had been. At the greatest distances from the heart, the viscous liquor of the joints is secreted; and some

some liquors, whose parts require no combination, as the *lymphæ*, may be secerned any where. All these different combinations, which form so many distinct fluids, arise from an attractive power in the parts of matter; which, though it be equally diffused through the whole mass yet according to the different densities of particles, and the figure of their parts, some sorts of particles will be soon united, whilst others require a longer time to be joined together; some particles will cohere more firmly than others, and particles of one kind will have a greater tendency to unite with those of another sort in a certain portion of their surface, than in any other. This attractive force is different from that by which Sir Isaac Newton explains the motions of the heavenly bodies; for the force of attraction, by which the planets preserve their motions, decreases only in a reciprocal duplicate proportion of their distances; whereas this other seems to decrease in a reciprocal triplicate, or in a greater proportion of the distances of the parts of matter from each other. But the cause of this attraction I have more fully explained in another discourse on animal secretion. The narrow limits of my design will not allow me to illustrate this opinion any farther. Another may be seen in Dr Cockburn's *Oeconomia animalis*, who is among the first who proposed to explain secretion, from the different velocities of the blood.

S E C T. XI.

Of the Pancreas and Succus Pancreaticus.

TH E *pancreas*, or sweet-bread, is a ^{Of the pancreas.} gland of the conglomerate sort, situated betwixt the bottom of the stomach and the *vertebræ* of the loins; it lies across the *abdomen*, reaching from the liver to the spleen, and is strongly tied to the *peritonæum*, from which it receives its common membranes. It weighs commonly four or five ounces. It is about six fingers breadth long, two broad, and one thick. Its substance is a little soft and supple; every little gland has a small excretory vessel, which uniting all together, form one common duct about the bigness of a quill, clear and transparent, like to the lymphatic vessel. This ^{Of the ductus pancreaticus.} duct runs all along the middle of the *pancreas*, and opens into the cavity of the *duodenum*, as its lower end, where there is a little caruncle at its orifice. Sometimes it joins the *ductus communis choledochus*, and then both open at one orifice into the *duodenum*. This canal was first found by *Virtfungus*, and is called *ductus pancreaticus Virtfungi*.

The *pancreas* receives arteries from the ^{Of the vessels of the pancreas.} *cœliack*. Its veins carry their blood into the splenick branch of the *vena portæ*, and the intercostal furnishes it with nerves. The use of the *succus pancreaticus* is to dilute the chyle with the liquor that is separated in the glands of the guts, that it may the more easily

Of the Liver and Gall-Bladder.

easily enter the mouths of the lacteal vessels.

S E C T. XII.

Of the Liver and Gall-Bladder.

Its situation.

THE liver lies in the right *hypochondrium*. Its convex and upper side reaches a little beyond the *cartilago-xiphoides*, and touches the *diaphragma*. Its concave and under side covers the *pylorus*, and part of the stomach, as also a part of the *colon*, all the *duodenum*, a part of the *jejunum*, and of the *omentum*. When we stand, its extremity goes near to the navel.

Its figure.

The liver is almost round, and pretty thick. Its upper side is convex, smooth, and equal; the other side is concave, but not so equal. In its middle and fore-part it is divided into two, by a fissure, where the umbilical vessels enter. The Gall-Bladder is fastened to its under side, where there are three eminences that the ancients called *portæ*, of which one passes for a little lobe. When it is full of blood, it is of a dark red colour; when the blood is washed out of it, it is pale and soft.

Its connection.

It is fastened in the body by two ligaments. The first, which is large and strong, comes from the *peritonæum* that covers the *diaphragma*, and penetrating the substance of the liver, it joins the *capsula* of the *vena portæ*. The second is the umbilical vein; its comes from the navel, and enters by the great

great fissure of the liver to join the *vena portæ*. After the birth, it degenerates into a ligament, but is of little use for the fastening the liver.

It is covered with a common membrane ^{Its mem-} from the *peritonæum*, besides that every lobe ^{brane.} and gland has its proper membrane.

The common membrane of the liver being ^{Its sub-} raised, its substance appears to be composed ^{stance.} of small glands of a conick figure, (not easily to be perceived in the human liver), and bound together by a proper membrane into several heaps or lobes, which, like bunches of grapes, hang to the branches of the vessels, from which each small gland receives a twig, and the lobes are tied to one another by small membranes, which fill up the spaces between them.

The vessels of the liver are, the *vena cava*, ^{Its vessels,} and the *vena portæ*. They are accompanied with many small branches of the arteries, which come from the *cæliack* and *mesenterica superior*. The *vena portæ* brings the blood full of bile for secretion, and the *cava* carries back the blood that remains.

The *vena portæ* and the *cava* enter the liver by its concave side, and are equally distributed through all its substance: wherever there is a branch of the one, there is a branch of the other; so that each globe, and each gland in the lobe, whether on the convex or concave side, receive the same vessels. The *vena portæ*, performing the office of an artery, brings the blood full of bile: which being strained off by the glands,

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the

Of the Liver and Gall-Bladder.

the rest of the blood is carried back by the branches of the *vena cava* to the heart.

It receives its nerves from the *plexus hepaticus* of the intercostal nerve.

Besides these vessels, the liver has lymphatick vessels, most of which open into the conglobate glands, near the *vena portæ*, on the concave side of the liver; from thence the lymph is carried by other lymphaticks, to the *receptaculum chyli*.

The excretory vessels of the liver. Of the gall-bladder.

We come now to the excretory vessels of the liver, which are the *vesicula fellis*, and *porus biliaris*. The *vesicula fellis*, or gall-bladder, is fixed to the concave side of the liver, into which its back part makes a small dent. Its figure is like that of a pear; it is of a different bigness almost in every subject; the biggest is about the bigness of a little hen egg. When the liver is in its natural situation, the bottom or largest part of the bladder is downwards, and the neck or narrowest part upwards; and then it touches the stomach as well as the *colon*, where it frequently dyes them yellow. This bladder is composed of three coats: the outermost is common to it with the liver; the next which is proper to it, is thick and solid, composed of transverse, oblique, and straight fibres; the third is thin and nervous. This last coat is covered within by a kind of crust or mucus, which preserves it against the acrimony of the bile, secreted probably by some small glands, which Malpighius has remarked, between its coats, where the cystick arteries end; which gave him ground to think that it was the same, in the *porus biliaris*.

bilarius. The bile is brought into the gall-bladder by some small vessels which arise from the neighbouring *glands*, and uniting, form one or two pipes which open at the neck of the bladder. These ducts I could never discover in any liver but an ox's, though I have reason to think that they are likewise in a human.

From the neck of the gall bladder there goes a pipe, not in a straight line with a bladder, but, as it were, more depressed in the liver: it is called *ductus cysticus*. Some Of the duct-
small biliary ducts open likewise into it, and *tus cysticus*.
its inner membrane has several *rugæ*, which retard the motion of the bile. To this pipe, which is about the bigness of a goose quill, is joined another called *ductus hepaticus*, or *Ductus he-*
porus bilarius. These two together make *paticus*.
the *ductus communis choledochus*, which goes obliquely to the lower end of the *duodenum*, or beginning of the *jejunum*. After it has pierced the first coat, it runs near two fingers breadth between the coats, before it opens in the cavity of the intestine; which oblique insertion serves instead of a valve to hinder the bile to return into the *ductus communis*, having once entered the intestine.

The gall-bladder has two veins from the *vena portæ*, which are called *cysticæ gemellæ*. It has some small arteries from the *cæliaca dextra*, and some lymphatics.

The *porus bilarius* is another excretory Of the *porus*
vessel of the liver. It has as many branches *bilarius*.
as the *vena portæ*, which it accompanies through every lobe and gland in the liver.

Wherever there is a branch of the one, there is a branch of the other; and these two are enclosed in one common capsule, as in a sheath: the use of this capsule is to facilitate the motion of the blood and bile, by the contraction of its fibres. All these branches unite, and make one trunk, of the bigness of a small quill, which joins (as we have said) the end of the *ductus cysticus*, for the carrying the bile from the liver to the intestines, by the *ductus communis chole-dochus*.

The insertion of the *porus bilarius* into the *ductus cysticus*, is oblique, with its mouth looking towards the *ductus communis*; by which means it is impossible that the bile which comes from the *cystis* can enter the *porus*, unless the *ductus communis* be stopped.

The bile which is found in the gall bladder, is thinner, and different from that which is in the *porus bilarius*. This Malpighius proves by an experiment, which is, that having tied the *ductus cysticus*, he remarked that the bile which came by the *porus bilarius*, was of a different taste, smell, colour, and consistency, from that in the gall-bladder.

The use of
the bile.

The use of the bile is to sheath or blunt the acids of the chyle; because they being entangled with its sulphurs, thicken it so as that it cannot be sufficiently diluted by the *succus pancreaticus* to enter the lacteal vessels. This appears not only from the analysis of the bile, which yields more of a lixivious than of a volatile alkaline salt: but likewise from what Leuwenhoeck has observed, that

that of the great quantity of acid salts he has seen amongst the aliments in the stomach, he never could find any in the chyle, after it had passed the *duodenum*.

Because some chyle is almost always passing through the *duodenum*, therefore it was necessary that the bile likewise should be continually poured into it from the *ductus hepaticus*. In a dog, whose *ductus communis choledochus* was near as big as a man's, I have gathered it at the rate of two drachms in one hour. But because a greater quantity of aliments requires a greater quantity of bile; therefore, according as the stomach is more or less distended with food, it presses out of the gall bladder a proportionable quantity of gall, to be mixed with the chyle in the guts.

S E C T. XIII.

Of the Spleen.

THE spleen is situated in the left *hypo-chondrium*, under the *diaphragma*, between the ribs and the stomach, above the left kidney: it is tied to the *peritonæum*, to the midriff, and to the *omentum*. It is of a bluish or leaden colour, of an oblong figure, thick at the edges, not thin, as the liver. It has two membranes: the external comes from the *peritonæum*.

Of the situation, connexion, and shape of the spleen.

The internal membrane is finer and thinner than the external: for if you blow upon the splenick artery, the air shall pass through

Of the internal membrane.

the one, but not the other. Its fibres are not irregularly woven, as those of other membranes seem to be; but as they come from innumerable points, as rays from so many centers, and the fibres of one point are regularly woven with the fibres of the points surrounding it. It receives veins, nerves, and arteries from those that enter the spleen.

Of the substance of the spleen.

The substance of the spleen is not only kept together by its two membranes, but also by innumerable fibres which come from the points of the internal membrane, and are inserted in the points of the opposite side of the same membrane; the expansion of the extremity of these fibres seem to compose the internal membrane.

The spleen is composed of an infinity of membranes, which form little cells and cavities of different figures and bigness, which communicate with one another, and which are always full of blood.

At the extremities of the blood-vessels, in the spleen of sheep, we find several small white and soft specks, which Malpighius calls glands.

Arteries.

The spleen has arteries from the *cœliack*, whose capillary branches make frequent inosculation among the membranes of the cells. Its veins, whose extremities communicate with the cavities of the cells, as they come out of the spleen, unite and make the *ramus splenicus* of the *vena portæ*, which carries the blood from the spleen to the liver. These, with its nerves, which are considerable from the *plexus splenicus*, are equally

equally distributed through the whole substance of the spleen, being all included in a common *capsula*. There are likewise a few lymphatick vessels which arise from the spleen, and discharge them into the lumbar glands.

The spleen being always full of a dark coloured blood, was by the ancients thought to be the receptacle of the *atra bilis*, a humour nowhere to be found. And all that has been said about its use by the moderns, has been so little satisfactory, that it has been generally acknowledged, that its use was still unknown. If we consider, that the bile is composed of particles, which slowly combine or unite together, and that by reason of the vicinity of the liver to the heart, and of the swift motion of the blood through the *aorta*, these particles could not in so small a time, and with so great a velocity, have been united together, had not the blood been brought through the coats of the stomach, intestines, and *omentum*, by the branches of the *vena portæ*, to the liver. But because all these parts were not sufficient to receive all the blood which was necessary to be sent to the liver; therefore nature framed the spleen, into whose cavities the blood being poured from a small artery, moves at least as slowly as any that passes otherwise to the liver; by which means the particles which compose the bile in the blood which passes through the *ramus splenicus*, by so long and slow a circulation, have more chances for uniting them, which otherwise they would not have had, had they been carried by the branches of

The use of
the spleen,

of the celiac artery directly to the liver; and consequently, without the spleen, such a quantity of bile is now fecerned, that is, as nature requires, could not have been fecerned by the liver. And this I take to be the true use of the spleen.

S E C T. XIV.

Of the Kidneys, Glandulæ Renales, Ureters and Bladder.

Of the
number and
figure of the
kidneys.

THE kidneys are two in number, one on each side; they have the same figure as kidney-beans: their length is four or five fingers breadth; their breadth is three, and their thickness two: the right is under the liver, and the left under the spleen. In a *fœtus*, their external substance is divided into several lobes joined together, which in adults becomes more close; therefore their superficies is equal and smooth: they have two membranes, the one common from the *peritonæum*, the other proper; they are ordinarily covered with much fat; their colour is a dark red.

Of their
vessels.

We observe in the kidneys, lymphatick vessels, which discharge themselves into *Pequet's* reservatory, nerves which come from the intercostals, veins which go to the *cava*; their arteries come from the *aorta*.

These veins and arteries are called *emul-gents*; they pierce the reins in their concave sides, (which ly nearest the *cava* and *aorta*), included in one capsule, and are divided in-

to

to several branches, which surround the *pelvis*. These branches are again divided into an infinity of other less, which go to the external part of the reins, where they inoscuate, and form a sort of net, from which their extremities coming, terminate in an infinity of little glands.

These glands are of a round figure; they compose the outer substance of the reins, ^{their substance,} which is half a finger thick. From each of

them there goes a long small tube; these tubes compose the inner substance of the reins. As they approach the *pelvis* or *bason*, they gather together in little bundles, whose extremities, piercing the membrane of the *pelvis*, form those little protuberances on the inside of the *pelvis*, called *papillæ*.

The *pelvis* or *bason* is a cavity in the middle of the kidneys, formed by a dilatation of the ^{of the pel-} ureters. It sends out several ramifications, which divide the urinary tubes into bundles, and which make a sort of *capsula* to the blood-vessels.

The use of the reins is to separate the urine from the blood, which, by the motion of the heart and arteries, is thrust into the emulgent branches which carry it to the little glands; by which the serosity being separated, is received by the orifice of the little tubes, which go from the glands to the *pelvis*; from thence it runs by the ureters into the bladder. The blood which could not enter the glands is brought back by the emulgent veins. ^{The use of the kidneys.}

In the middle between the *aorta* and the kidneys, a little above the emulgent vessels, ^{Of the glandulæ renales.} are

are situated the *glandulæ renales* or *capsula atrabiles*. They are two in number, one on each side, wrapt up in some fat: they sometimes change their situation, and their figure is also various; for in some they are round, in others square, triangular, or of an irregular figure; the right is ordinarily bigger than the left, and each about the bigness of a *nux vomica*: in a *fœtus*, they are always almost as big as the kidneys. They are covered with a fine membrane, and within they have several small *sinus's* which contain a blackish sort of liquor. Their blood-vefels are branches sometimes of the *vena cava* and *aorta*, and sometimes of the emul-gents.

their vef-
is and use.

The intercostal nerve furnishes a branch, which makes a *plexus* upon them. Their use is not yet known. Some think they separate a liquor from the arterial blood, for the liquoring the blood which is too thick after it comes from the kidneys.

of the ure-
ers.

The ureters are two long and small canals which come from the basons of the kidneys, one on each side: they ly betwixt the doubling of the *peritonæum*; and, descending in the form of an S, they pierce the bladder near its neck, where they run first some space betwixt its coats, and then they open to its cavity.

Their coats.

They are composed of three coats: the first is from the *peritonæum*: the second is made of some oblique muscular fibres: and the third, which is very sensible, has several small glands which separate a slimy liquor, to defend it against the acrimony of

of the urine. The neighbouring parts furnish them with blood-vessels, and their nerves come from the intercostals, and from the *vertebræ* of the loins. Their cavity is sometimes contracted in three or four places, especially towards the bladder. Such as are subject to the gravel, and given to excessive drinking, have them sometimes so much dilated, that you may put the end of your little finger into them. Their use is to carry the urine from the reins to the bladder. Their obstructions cause a suppression of the urine.

The bladder is situated between the duplicature of the *peritonæum*, in the lower part of the *abdomen*, between the *os sacrum* and the *os pubis*, above the straight gut in men, and the neck of the womb in women. It is tied to the navel by the *urachus* degenerated into a ligament, and its sides to the umbilical arteries; its neck to the *intestinum rectum* in women. The human bladder is not of the shape of a pear, as is commonly said, being rather biggest near its neck; the urine pressing mostly there, by reason of our erect station. It is composed of three coats: the first is a covering of the *peritonæum*. The second is composed of muscular fibres, which run irregularly several ways. And the third, which is full of wrinkles for facilitating its dilatation, is both glandulous, and nervous. Its glands separate a viscous and slimy matter, which defends it from the acrimony of the salts in the urine. Around its neck (which is longer in men than in women), there goes a small

Of the bladder.

Of the parts of Generation

small muscle called *sphincter vesicae*, which contracts the orifice of the bladder, that the urine may not run out; but when it thrusts open the passage, by the contraction of the second coat of the bladder, which is therefore called *detrusor urinæ*. The blood-vessels of the bladder are branches of the hypogastricks: its nerves come from the intercostals. Its use is, to be a reservatory of the urine, that it may not incessantly run from us, as it is separated in the kidneys.

We find in the urine much phlegm and volatile salt, a little sulphur, earth, and fixed salt.

S E C T. XV.

Of the parts of Generation proper to men.

THE parts of generation proper to men may be fitly divided into those which prepare and separate the seed from the blood, and those which convey it into the womb. The first is done by three sorts of glands, which are the *testes*, the *vesiculæ seminales*, and the *prostratæ*. The second is the office of the *penis*, or yard.

The *testes*, which prepare the principal part of the seed, receive their blood from two long and slender arteries, which, at their rise from the sides of the *aorta*, a little below the emulgents, are extremely small, but immediately become bigger; the reason of which mechanism we have already explained in speaking of secretion. As these

arteries run between the duplicature of the *peritonæum*, to which they give some small twigs, they pass out of the *abdomen* at the holes in the transverse and oblique muscles, and march over the *os pubis*, within the productions of the *peritonæum*, to the testicles; but, before they arrive, they divide each into two branches, the largest of which are spent upon the testicles themselves, and the two small ones upon the *epididymides*. When the blood has discharged itself of the seed into the testicles, it returns by the veins, which, rising in several branches from the *testes*, tend towards the *abdomen*, in the productions of the *peritonæum*, the same way the *arteries* came down. In their progress, their branches frequently inosculate, and divide again, till they come near the *abdomen*, then they all unite in one trunk; and therefore, because of their shape, are called *corpora pyramidalia*. In the *abdomen* they receive some small twigs from the *peritonæum*. The right spermatick vein opens into the *vena cava*, a little below the emulgent: but the left is always inserted into the emulgent of the same side, that it may not be obliged to cross the *aorta*, whose pulse would be apt to stop the blood which returns from the testicles very slowly, by reason of the narrow orifices of the spermatick arteries, and the largeness of the veins. These blood-vessels have been called the *vasa præparantia*.

Having described the blood-vessels of the *testicles*, I come now to their integuments, ^{The vasa præparantia.} which are three, one common, and two pro-

Of the scro-
tum.

per. The common is the *scrotum*, which besides the skin (which is very thin, and full of blood-veffels), scarf skin and *membrana adiposa*, in this place likewise very thin, its vesicles being empty of fat; is composed likewise of many fleshy or muscular fibres, by means of which the *scrotum* is contracted, which is reckoned a sign of health. This muscular lining of the *scrotum*, is by the Greeks called *dartos*. The *scrotum* is divided in the middle by a thin membrane, which separates the two *testicles*.

The tunica
vaginalis.

The first of the proper integuments is called *tunica vaginalis*, or *ἐλυθροειδής*, being formed by the dilatation of the productions of the external membrane of the *peritonæum*; its internal superficies is smooth, its external rough: it contains the *vasa præparantia* and *deferentia*; it embraces loosely the whole body of the *testicle*, adhering to one end of the *epididymis*. Upon the outside of this tunic runs a muscle called *cremaster*, from its office; it rises from the *os pubis*, and spreading its fibres upon the *elythroides*, it suspends the *testicles*, and draws them up in the act of generation.

Of the albuginea.

The second is that which covers immediately the *testicles*. It is called *albuginea*, because of its white colour. It is strong and thick, very smooth and equal. The branches of the *vasa præparantia* are finely waved upon it.

Of the substance of the
testicles.

The substance of the testicles, which formerly was thought to be a sort of marrow, is nothing but the folding of several small and soft tubes, disposed in such a manner, that

that if they could be separated from one another, without breaking them, they might be drawn out to a great length. They run in short waves from the *tunica albuginea* to the *axis* of the *testicles*, being divided from one another by thin membranous productions from the inner side of the *albuginea*. These productions unite at the *axis* of the *testicle*, and form a cover to some small tubes which at one end of the *testicle* pierce the *tunica albuginea*, and unite into one canal, which, by several turnings and windings upon the upper part of the *testicles*, forms that body which we call *epididymis*, covered with a thin production of the *albuginea*. The same canal continuing and ascending from the extremities of the *epididymis*, forms the *vasa deferentia*, one from each *epididymis*, about the bigness of a goose-quill: as they ascend within the *tunica vaginalis*, they make several short turnings and windings; then they enter by the holes of the transverse and oblique muscles into the *abdomen*, and marching over the ureters between the back side of the bladder and the *rectum*, they grow larger as they approach the *vesiculae seminales*, (which open into them), where they come close to one another, and, growing again smaller and smaller, they pass through the *prostatæ*, and open into the *urethra*, a little below the neck of the bladder, where each orifice has a spongy border, called *caput gallinaginis*, which hinders the involuntary running of the seed. The cavity of the *vasa deferentia*, before they enter the *abdomen*, will hardly admit of a

Of the epididymis.

Of the vasa deferentia.

hog's bristle; as they increase, so likewise do their cavities, which are tortuous and obliquely contracted by their inner coat, which is nervous, whiter and thinner than the external, which is composed of muscular fibres. The *testicles* have many lympheducts, which discharge themselves into the inguinal glands. Their nerves come from the intercostal, and 21st of the spine.

The spermatick arteries carry the blood from the *aorta* to the *testicles*, which separate that part of it which is fit for seed. The veins carry back to the *cava* what blood remains, after the secretion of the seed. The seed is farther purified in the *epididymides*, and in coition is carried by the *vasa deferentia* into the *urethra*. As the narrow orifices, and great length of the spermatick arteries (which give time to the slow moving particles of the viscous seed to combine and unite), are a clear proof of what we have said concerning the formation of the humours to be secreted; so the length of the tubes, which compose the body of the testicles, does not less evidently evince the structure we have given of a gland: for the particles which compose the seed being gross, all the smaller particles of the blood must enter the tubes with them; and therefore, that none but the particles of the seed might arrive at the *vas deferens*, it was necessary that the tube of the gland should be long, having many smaller branches, to convey off all the lesser particles, which were not to enter into the composition of the seed. Many of these particles must be lymphatick, because
of

of the great proportion they bear in the blood ; and therefore we find that the testicles, as well as the liver, have a multitude of lymphatick vessels. The reason of the length of the *vasa deferentia* is, that the *impetus* of the seed at the *caput gallinaginis* might not be sufficient to dilate the orifices of the *vasa deferentia*, but when assisted with the compression of the surrounding parts in copulation.

The *vesiculæ seminales* are two in number, one on each side, situated betwixt the bladder and the straight gut, tied to the one and the other by a membrane of the fleshy fibres, which in time of coition contracts and presses the *vesiculæ* : they are covered with a pretty thin membrane, upon which do creep many branches of veins, arteries, nerves, and lymphatics. Their external surface resembles rather that of the brains, than that of the guts of a little bird ; they are about two fingers breadth long ; their broadest part is not an inch, from which they grow narrower by little and little to their end, which is next the *prostatæ*. They have two considerable cavities divided into membranous cells, which open distinctly by two orifices, which are in their small extremities, into the two *vasa deferentia*, from which they receive the seed which is separated in the *testicles* to be kept till coition.

Of the vesiculæ seminales.

The *prostatæ*, or *corpus glandulosum*, is a conglomerate gland situated at the neck of the bladder, covered with a membrane made of muscular fibres, as that of the *vesiculæ*, and for the same use. It is about the big-

Of the prostatæ.

ness of a walnut. The *vasa deferentia* pass through its substance, which is vesicular and glandulous. The glands (which like little grains ly upon the sides of the vesicles) separate a clear and mucilaginous humour, which lies in the vesicles till coition, when it is carried into the beginning of the *urethra* by eleven or twelve excretory ducts, which open about the orifices of the *vasa deferentia*; the border of their mouth is all spongy, to hinder a continual running of this humour, which happens in a *gonorrhœa*, when their orifices are corroded by the morbid matter, which is thrust, by the elasticity of the air, into the empty ducts upon coition.

f the yard. The other principal member of the parts of generation, is the *penis* or yard, whose shape and dimensions are pretty well known. Its skin, which is thin, and without fat, has a reduplication, which makes a hood to the *glans*, or end of the yard, called *preputium*, or the fore-skin. The small ligament, by which it is tied to the under side of the *glans*, is called *frænum*. The use of the *præputium* is to keep the *glans* soft and moist, that it may have an exquisite sense.

The substance of the yard is composed of two spongy bodies called *corpora cavernosa*; they arise distinctly from the lower part of the *os pubis*. A little from their root they come close together, being only divided by a membrane, which at its beginning is pretty thick, but as it approaches the end of the yard, it grows thinner and thinner, where the *corpora cavernosa* terminate in the middle of the *glans*.

The

The external substance of these spongy bodies is hard, thick, and white. The internal is composed of small fibres and membranes which form a sort of loose net-work, upon which the branches of the blood-vessels are curiously spread. When the blood is stopt in the great veins of the *penis*, it runs through several small holes in the sides of their capillary branches into the cavities of the net-work, by which means the *corpora cavernosa* become distended, or the *penis* erected.

Along the under side of the *corpora ca-* Of the ure-
vernosa, there runs a pipe called the *urethra*, thra.
 which is about twelve or thirteen inches long, beginning at the neck of the bladder (from which it receives the urine) it bends to the lower part of the *os pubis*, and turning up to the roots of the *corpora cavernosa*, is continued to the end of the yard. The sides of this pipe are composed of two membranes, and a middle spongy substance, like that of the *corpora cavernosa*, except at the end, which joins the neck of the bladder; where the distance between the membranes is small, and filled up with a thin and red glandulous substance, whose excretory ducts piercing the inner membrane, pour into the pipe a mucilaginous liquor. The external membrane is hard, close, and white; the internal, which lines the cavity of the *urethra*, is thin, soft, and of an exquisite sense. The spongy substance which lies between the two membranes, is about half a line thick next to the *corpora cavernosa*, one half line round the rest of the pipe. The extremities
 of

of this spongy substance are much thicker than in the middle: that end next the *prostate*, because of its bigness, is called the bulb of the *urethra*, being about half an inch thick, and divided into the middle by a thin partition, as the *corpora cavernosa* are. The other end forms the *glans* or *balanus* upon the extremities of the *corpora cavernosa*. The veins in the *urethra* have holes in their sides, through which the blood passes into the cavities of its net-work, in an erection, as in the *corpora cavernosa*.

On each side of the bulb of the *urethra* there lies a small gland, whose excretory duct sloping forwards, pours into the *urethra* a viscid and transparent liquor, which defends it against the acrimony of the salts of the urine. And on the opposite side of the *urethra*, upon its internal membrane, a little nearer the *glans*, there is another small gland which has the same office. These glands were first observed by that diligent anatomist, Mr. Cowper. At the other end of the *urethra*, around the crown of the *glans* where it joins the *præputium*, is a row of small glands, like unto those of the *cilia*, called by that accurate anatomist, Dr. Tyson, *glandulæ odoriferæ*: they separate a liquor, which lubricates the *glans*, that the *præputium* may slip easily upon it.

Of the vessels of the yard.

The yard has a small ligament which arises from its back, a little distance from its root, which ties it to the upper part of the *os pubis*, that it may not hang too low. It receives two branches of veins and arteries from

from the hypogastrick vessels; besides the others from the *pudenda*. The two veins unite near its roots, and form one trunk that runs along the upper side of the yard. It has two nerves from the *os sacrum*, and several lymphatics, which empty themselves into the inguinal glands.

The yard has three pair of muscles. The first is the *erectores*; they rise from the *ischium*, a little below the roots of the *corpora cavernosa*; they ly upon them, and are inserted into them. The second are the *acceleratores*; they rise from the root of the *urethra*; they have several fibres, which join the fibres of the *sphincter ani*; they ly upon the *urethra*, betwixt the two former, and are inserted into the *corpora cavernosa*. The third pair are the *transversales*; they arise from the *ischium*, just by the *erectores*, and run obliquely to the upper part of the bulb of the *urethra*. When these muscles act, they press the veins upon the back of the *penis* against the *os pubis*, which is the cause of the erection, as has been said.

S E C T. XVI.

Of the Parts of Generation proper to Women.

HAVING in the first chapter described the figure and situation of the external parts of generation proper to women; I shall here only examine their substance and use, and then proceed to the internal parts.

The

Of the clitoris.

The *clitoris*, which is in the fore-part of the *vulva*, is a long and round body, naturally about the bigness of the *uvula*: it lies within the skin; nor does any part of it appear outwardly, except its extremity, which is covered with a folding of the skin, made by the union of the *nymphæ*, called its *præputium*. The substance of the *clitoris* is composed of two spongy bodies, such as those of the yard: they rise distinctly from the lower part of the *os pubis*, and approaching one another, they unite and form the body of the *clitoris*, whose extremity, which is of an exquisite sense, is called its *glans*. The two spongy bodies, before they unite, are called the *crura clitoridis*, they are twice as long as the body of the *clitoris*. It has two

Its muscles.

muscles, which rise from the protuberance of the *ischium*, and are inserted in its spongy bodies. They erect the *clitoris* in coition, after the same manner that the muscles of the yard do erect the yard.

Its vessels.

The *clitoris* receives veins and arteries from the hæmorrhoidal vessels and the *pudenda*, nerves from the intercostals, which are likewise distributed through all the parts of the *vulva*. Remark, that the veins on the one side of the *vulva* communicate with those of the other side, and so do the arteries communicate with one another.

Of the nymphæ.

The *nymphæ* have been sufficiently described already. Their internal substance is spongy, and full of blood-vessels, therefore they swell in the act of copulation; they receive vessels and nerves as the *clitoris*; their use is to defend the internal parts from
exter-

external injuries, to increase pleasure in coition, to direct the course of the urine: they are bigger in married women than in maids.

The *hymen* is a circular folding of the inner membrane of the *vagina*; which being broke at the first copulation, its fibres contract in three or four places, and form what they call *glandulæ myrtiformes*.

A little beyond the *clitoris*, in the fore part Urethra. of the *vulva*, above the neck of the womb, there is a little hole, which is the orifice of the *urethra*: it is naturally so large as to receive a probe as big as a goose-quill. The length of the neck of the bladder is near about two fingers breadth. It has a little muscle called its *sphincter*, which embraces the *urethra*, to hinder the involuntary running of the urine; it joins the fleshy fibres which are at the orifice of the *vagina*.

Between this muscle and the inner membrane of the *vagina* there are several little glands, whose excretory ducts are called *la-Lacunæ.* *cunæ*: they pour a viscous liquor, for the tickling of the sex, into the lower part of the *vulva*. These glands are the seat of the *gonorrhæas* in women, as the *prostatæ* are in men; and have the same use that they have. They have been found all ulcerate in women which have had a *gonorrhæa*.

The *vagina*, or neck of the womb, is a Vagina, long and round canal, which reaches from the *pudendum* to the internal mouth of the womb. In maids it is about five fingers breadth long, and one and a half wide; but in women who have born children, its length and bigness cannot be determined, because

Of the Parts of Generation

because it lengthens in the time a woman is with child, and it dilates in the time of birth. It lies betwixt the bladder and the *rectum*, with which last it is wrapt up in the same common membrane from the *peritonæum*; for this reason the excrements come out sometimes by the *vulva*, when this intestine is wounded.

The substance of the *vagina* is composed of two membranes, of which the inner, which lines its cavity, is nervous, and full of wrinkles and *fulci*, especially in its fore part, It has three or four small glands on that side next the *rectum*, which pour into it a viscous humour, in the time of coition, of which we have spoken before.

The wrinkles of this membrane are for the friction of the *balanus*, to increase the pleasure in copulation, to detain the seed that it may not run out again, and that it may extend in the time of gestation.

The external membrane of the *vagina* is made of muscular fibres, (which as occasion requires) dilate and contract, become long and short, for adjusting its cavity to the length and bigness of the yard. At its lower part there is a muscle of circular fibres like a Sphincter, and under it, on each side of the *vagina*, a net-like *plexus* of blood-vessels, which, with the muscle, helps to straiten the mouth of the *vagina*, that it may grasp the yard closely.

The neck of the womb receives veins and arteries from the hypogastrick and the hæmorrhoidal vessels. Those from the hypogastrick are dispersed in its upper part, and those

those from the hæmorrhoidal in its lower part. These vessels communicate with one another. It has nerves from the *os sacrum*. Among other uses the neck of the matrix serves for a conduit to the *menstrua*, and for a passage to the *fœtus*.

The matrix or womb is situated in the lower part of the *hypogastrium*, betwixt the bladder and the strait gut; the *os pubis* is a fence to it before, the *sacrum* behind, and the *ilium* on each side; these form as it were a basin for it; but because it must swell whilst women are with child, therefore they leave a greater space in them than men; it is for this reason that women are bigger in the haunches than men.

The figure of the womb is like a pear, from its internal orifice to its bottom; it is three fingers long, two broad, and almost as much thick. In maids its cavity will contain a big almond: it changes both figure and dimensions in women that are with child; it presses the bowels, and reaches to the navel towards their delivery, whilst at other times it does not pass the *os sacrum*.

The womb is covered with the *peritonæum*. Its substance is composed of fleshy fibres, which are woven together like a net, and they draw together and make several bundles, which have several directions, for the better contracting of the womb in the expulsion of the *fœtus*. The spaces between these fibres are filled up with thin and soft membranes, which form an infinite number of cells, upon which the blood-vessels run; turning and winding frequently. Upon these

H

these

these membranes, especially towards the cavity of the womb, there are several glands which separate an humour to lubricate the cavity of the womb.

The bottom of the womb grows thick, as it dilates; so that in the last month of gestation, it is at least an inch thick, where the *placenta* adheres, because its roots run into the substance of the womb.

The entry into the cavity, or the mouth of the womb, joins the upper end of the *vagina*, and makes a little protuberance in the form of lips, and resembles the muzzle of a little dog, by some called *os tinæ*. The cavity of the womb next its internal orifice being more contracted than it is near to its bottom, is called *collum minus uteri*. Its surface is unequal, and, among its *rugæ*, open several small ducts, which discharge a glutinous liquor to seal up the mouth of the womb in gestation. The ducts are affected in a *fluor albus*.

Of its vessels,

The veins and arteries of the womb are branches of the hypogastrick and spermatick vessels, whose larger ramifications inosculate with one another; the spermatick artery with the hypogastrick, and the vein with the vein, as also the branches of one side of the womb with those of the other. When the term of accretion draws to a period, and the blood which was wont to be spent in the increase of the body, being accumulated, distends the vessels, it breaks forth once a month, at those of the womb; because of all the veins in the body, which stand perpendicular to the horizon, these only are without

without valves. This evacuation is called the *menstrua*, to which men for the same reason are subject, but in them the redundant humour passes off by urine, as Sanctorius observes, and rarely by the hæmorrhoidal veins.

Its nerves come from the intercostals, and from those which come from the *os sacrum*. There are also several lymphatics upon its outside, which unite by little and little into greater branches, and discharge themselves in the reservoir of the chyle. All the vessels of the womb creep upon it by many turnings and windings, that they may not break when it is distended,

The womb is tied by two sorts of ligaments; by two broad, called *ligamenta lata*; and by two round, called *ligamenta rotunda*. The two broad ligaments are only a production or continuation of the *peritonæum* from the sides of the womb. For their largeness and figure, they are commonly compared to the wings of a bat. The *ovaria* are fastened to one end of them, and the *tubæ fallopianæ* run along the other. Of its ligaments.

The two round ligaments rise from the fore and lateral part of the bottom of the womb, and pass, in the productions of the *peritonæum*, through the rings of the oblique and transverse muscles of the *abdomen* to the *os pubis*, where they expand like a goose-foot, and are partly inserted in the *os pubis*, and partly continued or joined to the *musculus membranosus*, or *fascia lata*, on the upper part of the inside of the thigh; from thence comes the pain that women, big with child,

feel in this place. The substance of these ligaments is hard, but covered with a great number of blood vessels; they are pretty big at the bottom of the womb, but they grow smaller and flatter as they approach the *os pubis*.

Of the spermatick vessels

The spermatick vessels in women are four, as in men; they differ only in this, that they are shorter, and the artery makes several turnings and windings as it goes down, that it divides into two branches, of which the smallest goes to the *ovarium*; the biggest divides into three more, of which one is bestowed upon the womb, another upon the *vagina*, and the third upon the ligaments of the womb and *tubæ fallopianæ*: it is the same as to the vein.

Of the situation and figure of the ovaria.

The *ovaria* are tied about two fingers distance from the bottom of the womb by the *ligamenta lata*. They are fixed to the *peritonæum* at the *ilia*, by the spermatick vessels. They are of an oval figure, a little flat upon their upper part, where the spermatick vessels enter.

Of their membranes and substance.

The *ovaria* or testicles are near half as big as mens are; their surface is unequal and wrinkled in old women, but smooth and equal in maids; they are covered with a proper membrane, which sticks close to their substance, and with another common from the *peritonæum*, which covers all the spermatick vessels. Their substance is composed of fibres and membranes, which leave little spaces, in which there are several small vesicles, round, full of water, which being boiled, hardens like the white of an egg; they have

have each of them two proper membranes, upon which there are several small twigs of veins, arteries, and nerves. These vesicles are called eggs, and they are of a different size and number, in women of different ages. We observe in cows, that such of them as are impregnated after copulation, are contained or covered all over with a yellow substance, which has a small hole in its side, through which they are thrust when they fall into the *tubæ fallopianæ*. Besides the spermatick vessels, the *ovaria* have nerves from the intercostals and lymphatics, which discharge themselves into the common receptacle.

The *tubæ fallopianæ* are situated on the right and left side of the womb; they rise from its bottom by a narrow beginning, and they dilate in form of a trumpet to their extremities, where they are contracted again into a small orifice, from whose circumference they dilate into a pretty broad membrane, which looks as if it were torn at its edges, therefore called *morfus diaboli*. Their cavity, where they open into the womb, will scarcely admit of a hog's bristle; but at its widest part it will take in the end of one's little finger. Their substance is composed of two membranes, which come from the external and internal membranes of the womb. The tubes are about four or five fingers breadth long; they have the same veins, arteries, nerves, and lymphatics, as the *ovaria*. These are all the parts of generation in women.

The use of
these parts
in genera-
tion.

So great is the pleasure in the act of generation, that it alters the course of the blood and animal spirits, which then move all the above-described parts, which before lie quiet and at rest. The *clitoris* is erected, which, by its exquisite sense, affords a great deal of delight; the glands about the neck of the womb, being pressed by the swelling of the neighbouring parts, pour forth a liquor to facilitate the passage of the yard, and to increase the pleasure. The neck of the womb contracts and embraces closely the yard; the fibres of the womb contract and open its mouth (which at other times is extremely close) for the reception of the spiritous part of the seed; and the branches of the spermatick artery; which run upon the *ligamenta lata*, between the *ovaria* and the *tubæ fallopianæ*, being distended with blood, contract and pull the extremities of the tubes to the *ovaria*, for carrying the seed to them. The seed impregnates the egg, which, from being transparent becomes opake some time after; it is covered with a thick and yellow substance, which presses it on all sides, and thrusts it out through a little hole in its middle: so it falls into the orifice of the tubes, which dilate sufficiently for its passage into the womb.

Some, partly considering the closeness of the mouth of the womb, and partly the thickness of the membranes of the *ovaria* and *ova*, do judge it impossible for the seed to pass this way; therefore they think that it is taken up by the veins which open in the cavity of the *vagina* and *matrix*, where circulating,

culating, it ferments with the mass of blood : from thence come all those symptoms which appear in conception : it enters and impregnates the egg by the small twigs of arteries which are upon its membranes. This fermentation swells the membranes of the *tubæ*, opens the cavity of the womb, and makes every thing ready for the reception of the egg.

S E C T. XVII.

Of the Generation of the Fœtus ; Of the Umbilical Vessels ; Of the Placenta ; Of the Posture of the Fœtus, and Term of Delivery.

THE great and many difficulties which attend the most plausible account of the first formation of the parts of an animal, and beginning of motion in its fluids ; and the nice and curious observations of Redi, Leeuwenhoeck, and others, have been sufficient motives to most of the moderns to throw off the notion of equivocal generation. But though both reason and experiments convince us, that all the parts of an animal did exist, and its fluids were in motion, before generation ; yet whether the *animalcula* was lodged in the seed of the male or female *ova*, is matter of controversy. The arguments, strongly alledged on both sides, persuade me of the truth of what Dr. *Garden* says, that the female *ovum* is a proper *nidus* for the *animalcula in semine*. It is amazing to see the prodigious number of little creatures, like so many tadpoles, swimming every way

way in the male sperm of all animals: nor is it less curious to observe their languid motion, in such as are poxed, and how they recover their former briskness as the distemper abates. Leeuwenhoeck tells us of one whose wife for some years did not conceive, because there were no *animalcula* to be found in his seed, there being no other visible hindrance on either side. These animals are so small, that 3000,000,000 of them are not equal to a grain of sand, whose diameter is but the hundredth part of an inch. Whilst the seed thus abounds with *animalcula*, there are not the least rudiments of an animal to be seen in any part of the *ovaria*: yet these likewise have a principal part in generation, for without them there is no conception; and even bitches, which have been spayed, forget their usual appetites, as if they were the only spurs to venery. The yellow substance which grows in the *ovaria* of cows, upon conception, is very remarkable: it has a small dint, and a cicatrice in its middle, as if the *ovum* had dropt out there (as Malpighius thinks). When the *fœtus* is very small, I have observed it very large; but as the *fœtus* grows bigger and bigger, this decays, and, I think, at last even vanishes: nor is it to be seen before conception, and in one testicle only, when there is but one calf. If all the *animalcula*, or a great many of them, did fasten and grow to the womb, till such time as by their bigness, or want of nourishment, they made one another drop off, (as Leeuwenhoeck thinks), women could not but be sensible of their evacuation;

tion; for they must be falling off, through the whole time of their being with child. But when the *animalcula* gets into an *ovum* fit to receive it, and this falls through one of the *tubæ fallopianæ* into the womb, the humours which distil through the vessels of the womb, penetrating the coats of the egg, swell and dilate it, as the sap of earth does seed thrown into the ground. Or else the branches of the *veins* and *arteries*, whereby the egg was tied in the *ovarium*, (which probably make the umbilical vessels) being broken, fasten with the vessels of the womb; then the *placenta* begins to appear like a little cloud upon one side of the external coat of the egg; and at the same time the spine of the *embryo* is grown so big, as to be visible; and a little after the *cerebrum* and *cerebellum* appear like two small bladders, and the eyes next stand gogling out of the head; then the beating of the heart, or *punctum saliens*, is plainly to be seen; and the extremities discover themselves last of all.

Now the membranes which involve the *fœtus* are the same with the coats of the egg. The external is called *chorion*; it is pretty thick, and a little rough on its outside, to which the *placenta* adheres. It embraces immediately the *amnion*, or internal membrane, which is a fine and delicate bag full of clear liquor, in the middle of which the *fœtus* swims. This liquor is separated, for the nourishment of the *fœtus*, by the glands of the *amnion*, from its blood-vessels, which are fine branches of the umbilical vein and arteries.

The

The *arteries* rise from the extremity of the *aorta*, or the beginning of the iliacks of the *fœtus*; and, passing by the sides of the bladder to the navel, through which they pass, they give some branches to the *amnion* and *chorion*, and are afterwards divided into an infinite number of branches in the *placenta*. The vein rises by several roots or branches which are spread through all the substance of the *placenta*; it enters the *chorion* and *amnion*, to which it gives several twigs; and, passing in at the navel, it joins the *vena portæ*, in the substance of the liver.

The use of
the navel-
string.

The umbilical vessels between the navel and the *placenta* are wrapt up in a production of the *chorion* and *amnion*, which is generally about a foot and a half long, that the motion of the *fœtus* might not pull the *placenta* from the womb. The use of this navel-string is to carry the maternal blood of the veins to the *fœtus*, for its nourishment: that which is unfit for this use, is carried back by the arteries to the *placenta*, whilst the *fœtus* is still supplied with more by the veins; so that there is a continual circulation betwixt the mother and the *fœtus*.

Of the pla-
centa.

Now the *placenta* is a thick cake which grows upon the outside of the *chorion*, in proportion as the *fœtus* grows; it is of a circular figure, at its biggest it is about two fingers breadth thick, and six or seven in diameter. The branches of the umbilical vessels are spread through all its substance; and indeed, it seems to be nothing else but a texture of the vein and arteries, by whose extremities

extremities opening into the sides of the hypogastrick vessels, the circulation is performed between the mother and the *fœtus*; for that side of the *placenta* which adheres to the womb, appears to be nothing but the extremities of an infinite number of small threads, which, in labour, dropping out of the pores in the sides of the hypogastrick blood vessels, into which they had insinuated themselves, is the occasion of the flowing of the *lochia*, till the *uterus* collapses, or the pores, by the natural elasticity of the vessels, contract by degrees. Sometimes twins have only one common *placenta*, and sometimes they have each a distinct one.

Besides these membranes which involve the *fœtus*, there is another, which lies between the *chorion* and the *amnion*, on the opposite side to the *placenta*, in the form of a bag, called the *allantois*; it receives the urine of the *fœtus* from a pipe called the *urachus*, which rises from the bottom of the bladder, and passes out at the navel, to which place its cavity is very apparent, but hardly to be perceived afterwards in the umbilical rope, though there are not wanting some good anatomists who have observed it even there. However, its being rarely found, has given ground to many anatomists to doubt of the existence of the human *allantois* itself, the opportunities of opening the dead bodies of women big with child being very rare. Yet if we consider, that there seems to be the same necessity for the secretion of the urine of the human *fœtus*, that there is for that of brutes, and that we actually

actually find urine in the bladder of the first, as well as of the last, we cannot doubt, but that Nature would provide for the one, as well as for the other. And that she really has done so, we may gather from this, that midwives do generally observe two different sorts of water to come away in labour. And I have seen a human *allantois* with all the secundines curiously prepared by Dr. Hale, of which he has given a full account in the *Philosophical Transactions*.

Of the posture of the fœtus.

The *fœtus* is almost of an oval figure whilst it lies in the womb, for its head hangs down with its chin upon its breast; its back is round: with its arms it embraces its knees, which are drawn up to its belly; and its heels are close to its buttocks, its head upwards, and its face is towards its mother's belly. But, about the ninth month, its head, which was always specifically lighter than any other part, becomes specifically heavier, its bulk bearing a much smaller proportion to its substance than it did, and consequently it must tumble in the liquor which contains it; so its head falls down, its feet get up, and its face turns towards its mother's back: but because then it is an irksome tho' favourable posture for its exit, the motion it makes for its relief, gives frequent pains to its mother, which causes a contraction of the womb, for the expulsion of the *fœtus*. When the child presents in any other posture, it should be carefully put back again, and, if possible, turned to the right way; if that cannot be done, it should be brought out by the feet.

C H A P. III.

Of the Thorax or middle Cavity.

S E C T. I.

Of the Breasts.

HAVING already described the figure, bounds, and external parts of the *thorax*, we come now to examine the substance and use of its several parts, among which the first that presents itself is the breasts.

The substance of the breasts is composed of a great number of glands of an oval figure, which ly in a great quantity of fat. Their excretory ducts, as they approach the nipple, join and unite together, till at last they form seven, eight, or more small pipes, called *tubuli lactiferi*, which have several cross canals by which they communicate with one another, that, if any one of them be stopt, the milk, which was brought to it, might not stagnate, but pass through by the other pipes, which all terminate in the extremity of the nipple.

The nipple is a spongy substance, made of two orders of fibres: the smallest make a fine net-work within the larger spaces of the net-work of the bigger fibres. Through it pass the *tubuli lactiferi*, which grow smaller and smaller to their extremities, that the milk might not run out, but when the breasts are full, or upon suction:

- it has an exquisite sense, and a small erection when it is handled.

The *arteries* and *veins* of the breasts are branches of the subclavian and intercostal. They have nerves from the vertebral pairs, and from the sixth pair of the brain.

The use of the breast is to separate the milk for the nourishment of the *fœtus*. The tubes, which compose the glands of the breasts in maids, like a sphincter muscle, contract so closely, that no part of the blood can enter them: but when the womb grows big with the *fœtus*, and compresses the descending trunk of the great artery, the blood flows in a greater quantity, and with a greater force through the arteries of the breasts, and forces a passage into their glands, which, being at first narrow, admits only of a thin water; but, by growing wider by degrees, as the womb grows bigger, the glands receive a thicker serum; and after birth they run with a thick milk, because that blood, which before did flow to the *fœtus*, and for three or four days afterwards by the *uterus*, beginning there to stop, does still more dilate the glands of the breasts.

The breasts in men are very small; they are chiefly for an ornament. I have seen some men who have had milk in them.

S E C T. II

Of the Diaphragma, or Midriff.

Of the two muscles which compose the midriff.

UNDER the breasts ly the muscles and bones which compose the fore-part of

of the *thorax*; these are described in their places: having therefore cut them up, and laid the cavity of the *thorax* open, the *diaphragma*, *pleura*, *mediastinum*, heart, and lungs appear.

The *diaphragma* is composed of two muscles, which divide the middle from the lower cavity. The first and superior muscle arises from the *sternum*, and the end of the last ribs, on each side. Its fibres, from this semi-circular origination, tend towards their centre, and terminate in a tendon or *aponeurosis*, which hath always been taken for the nervous part of the midriff. The second and inferior muscle comes from the *vertebræ* of the loins, by two productions, of which that on the right side comes from the first, second, and third *vertebræ* of the loins; that on the left side is somewhat shorter; and both these productions join and make the lower part of the midriff, which joins its tendon with the tendon of the other, so as that they make but one membrane, or rather partition.

The midriff is covered with a membrane from the *pleura* on its upper side, and by the *peritonæum* on its lower side; it is pierced in its middle, for the passage of the *vena cava*; and its lower part, for the *œsophagus*; and the *nerves* which go to the upper orifice of the stomach, and betwixt the productions of the inferior muscle, pass the *aorta*, the thoracick duct, and the *vena azygos*.

The midriff receives *arteries* and *veins* called *phrenicæ* from the *cava* and *aorta*; and sometimes on its lower part two branches

from the *vena adiposa*, and two *arteries* from the *lumbares*. It has two *nerves* which come from the third *vertebra* of the neck, which pass through the cavity of the *thorax*, and are dispersed in the muscles of the midriff.

Of its use.

The midriff, in its natural situation, is convex on the upper side towards the breast, and concave on its lower side towards the belly: therefore, when its fibres swell and contract, it must become plain on each side: and consequently the cavity of the breast is enlarged, to give liberty to the lungs to receive the air in the inspiration: and the stomach and intestines are pressed for the distribution of the chyle; but it diminishes the cavity of the breast, when it resumes its natural situation, and presses the lungs for the expulsion of the air in expiration.

S E C T. III.

Of the Pleura, Mediastinum, and Thymus.

Of the pleura.

THE *pleura* is a double membrane which covers all the cavity of the *thorax*; it arises from the *vertebra* of the back, ascends on each side upon the ribs to the middle of the *sternum*. It is fixed to the *periosteum* of the ribs, to the internal intercostal muscles, and it covers the midriff. Its side towards the cavity is smooth and equal, but that which is fixed to the ribs is rough.

Of the mediastinum.

The *mediastinum* is a double membrane, formed by the continuation of the *pleura*, which comes from the *sternum*, and goes straight

straight down through the middle of the *thorax* to the *vertebrae*, dividing the cavity in two. It contains, in its doubling, the heart in its *pericardium*; the *vena cava*, the *oesophagus*, and the stomachick nerves. The membranes of the *mediastinum* are finer and thinner than the *pleura*, and they have a little fat. The *mediastinum* receives branches of *veins* and *arteries* from the mamillary and diaphragmatick, and one proper, called *mediastina*; its *nerves* come from the stomachick; it has also some lymphaticks, which open into the thoracick duct. The *mediastinum* divides the *thorax* into two parts, to the end that one lobe of the lungs may officiate, if the other be hindered by a wound on the other side of the *thorax*. Sometimes there is a matter contained betwixt its membranes immediately under the *sternum*, which may occasion the trepaning of this place.

The *thymus* is a conglobate gland, situated in the upper part of the *thorax*, under the *claviculae*, where the *cava* and *aorta* divide into the subclavian branches. This gland is big in infants, but as they grow in age, it grows less. Its *arteries* and *veins* are branches of the *carotides* and *jugulars*. It has *nerves* from the *par vagum*, and its lymphatick vessels discharge themselves in the *ductus thoracicus*. Of the thymus.

The learned Dr. Tyson supposes the use of this gland to be for a *diverticulum* to the chyle in the thoracick duct of a *fœtus*, whose stomach being always full of the liquor in which it swims, must keep the thoracick duct distended with chyle; because

the blood which the *fœtus* receives from the mother fills its veins, and hinders the free entrance of the chyle into the subclavian vein. Nor can any argument be drawn from the *valves* in the lympheducts of the *thymus*, against this opinion; for I have more than once injected them with wax up to the *thymus*, by the thoracick duct, as Mr. Cowper likewise observes.

S E C T. IV.

Of the Pericardium, Heart, and its Parts.

Of the pericardium.

THE *pericardium* is a thick membrane, of a conick figure; it resembles a purse, and contains the heart in its cavity. Its basis is pierced in five places, for the passage of the vessels which enter and come out of the heart: it lies in the duplicature of the *mediastinum*, which firmly adheres to it, as its point does to the middle tendon of the midriff. It receives its vessels from the mammary and *phrenicæ*, nerves, from the recurrent and diaphragmatick. It has lymphatics which discharge themselves in the thoracick duct.

Of the water contained in the pericardium.

The use of the *pericardium* is to contain a spoonful or two of a clear water, which is separated by some small *glands* in the *pericardium*, that the surface of the heart may not grow dry by its continual motion.

Of the situation, figure, and connection of the heart.

The heart is situated in the middle of the *thorax*, between the two lobes of the lungs; it is of a conick figure, whose *basis* is the upper end, and its *apex* or point is the lower end, which is turned a little to the left

left side, that the right auricle may be lower than the left; by which means the refluent blood in the *cava* ascends the more easily; for, like other liquors, the blood will rise to the same height in both legs of a reflex tube. For the same reason the *aorta* runs first upwards, before it turns down, that the force of the returning blood from the lower parts may be the greater.

The heart is tied to the *mediaſtinum*, to the *pericardinum*, and ſuſtained by the great veſſels which bring and carry back the blood. It is covered by a membrane which is the proper membrane of the muſcle; its baſis is always ſurrounded with fat. It has two ^{Of its veſ-}veins, which open into the *cava*, immediately ^{fels.} before it empties itſelf into the auricle, and they are accompanied with two arteries from the *aorta*, which run through all the ſubſtance of the heart; they are called the *coronary veſſels*. The arteries bring the blood for the nutrition and motion of the heart, and the veins carry back what remains. The branches of the veins on the right ſide communicate with thoſe of the left. In like manner do the arteries of each ſide communicate with one another; and it is the ſame, though not every where ſo evident, in all the parts of the body. The heart receives a multitude of ſmall nerves from the eighth pair; particularly they creep in great numbers about the *aorta*, and on the left ventricle. It has alſo ſome lymphatics, which diſcharge themſelves in the thoracick duct.

At the baſis of the heart there are two ^{Of the au-}auricles, ^{riculæ.}

auricles, or little ears, one on the right, the other on the left side. In the right ear opens the *vena cava*, in the left the *vena pulmonalis*. The first discharges the blood that it receives from the *cava* into the right ventricle, and the second thrusts the blood that comes from the *vena pulmonalis* into the left ventricle. The left is less, but thicker than the right. Their substance is composed of two orders of muscular fibres, which terminate in the tendon in the basis of the heart; and at the right ear there is a circle like to a tendon, where the *cava* ends. Their external surface is smooth; their internal is unequal, full of small fleshy pillars, which send out small fibres, that cross and go athwart one another; and betwixt these pillars there are as many furrows; they receive nerves from the branches of the eighth pair. They have the same motions of *systole* and *diastole* as the heart, which we shall explain afterwards. Their use is to receive the blood which is brought by the *vena cava* and *pulmonalis*, and by them to be thrust into the ventricles of the heart.

Of the ventricles of the heart.

In the heart there are two cavities or ventricles, which answer to the two ears, one on each side; the sides of these cavities are very unequal, full of fibres and little fleshy productions, long and round, of a different figure and bigness, called *columnæ*, or pillars. Betwixt these fibres there are several furrows in the sides of the ventricles; especially in the left ventricle, they are deeper and larger; they contribute much to the close contraction of the ventricles. And because the

the side of the right ventricle is much thinner than the left, therefore there is often a small bundle of fleshy fibres, which come from the middle partition to its opposite side, to hinder it from dilating too much.

The right ventricle seemeth wider than the left, which is longer and narrower than the right, and its sides stronger and thicker. The two ventricles are separated by the *septum medium*, which is properly the inside of the left ventricle, being its fibres, are continued with the fibres of the opposite side of the same ventricle. The vessels which enter and come out of the heart are the *vena cava*, the *arteria*, and *vena pulmonalis*, and the *aorta* or *arteria magna*.

The right ventricle receives the blood from the *vena cava*, through the right ear; and at the mouth of the ventricle there are placed three valves, made of a thin membrane; they are of a triangular figure, and are called *tricuspides*; their bases are fixed to the mouth of the ventricle, and their points and sides tied by small fibres to the fleshy productions. So that when the ventricle contracts, and the opposite sides approach one another, the points of the valves meet, and, their lateral strings being relaxed, their sides are likewise made to join one another by the blood which gets between them and the sides of the ventricle; the three valves thus united form a concave cone, which hinders the return of the blood to the auricle. It is therefore thrust out at

The *arteria pulmonalis*, which rises immediately out of the right ventricle: its mouth

Of the right ventricle, and of its valves. Of the valves of the *arteria pulmonalis*.

is less than the *cava*; it has three valves, called *sigmoidales*, or *semilunares*, because they resemble a half-moon, or the Greek sigma, which was writ thus, *C*. Their substance is membranous. When they separate they give passage to the blood, from the ventricle into the artery; but they shut the passage, and are thrust together by the blood, if it endeavours to return. The *arteria pulmonalis* carries the blood to

Of the
valves of
the left
ventricle.

The *vena pulmonalis*, which discharges itself through the left ear into the ventricle of the same side. At the orifice of this ventricle there are two valves, called *mitrales*, because they resemble a mitre; they are broader than the other valves; they are situated, and have the same use as the *tricuspides* in the right ventricle.

Of the
valves of
the aorta.

The *aorta*, or great artery, rises immediately out of the left ventricle; it has three valves, which have the same use and figure as the *semilunares* in the *arteria pulmonalis*.

Of the sub-
stance of the
heart, and
of the order
of its fibres.

The heart is a compound muscle; its substance is made of fibres of the same nature of those other muscles: there are several orders of them, which have different directions, and all their tendons are in the basis of the heart. From the *aorta*, just by one of the coronary arteries, go out two tendons, of which the first passes between the pulmonary artery, and the right auricle, the other between the two auricles: these surround the entry both of the *aorta* and left ventricle. The entry of the right is likewise tendinous, but all the fibres which terminate

minate about the pulmonary artery, terminate fleshy.

Now of the fibres which come from the mouths of the right ventricle and pulmonary artery, the outermost, which are much the finest, go in a straight line to the point of the heart. All the other which are next the surface of the heart, wind towards the left hand, till they arrive at the point, where turning underneath themselves, and under the right ventricle, they wind upon the left ventricle towards the right hand, to their insertion in the basis. Under the straight fibres there pass a few more, almost straight, from the mouth of the right ventricle to the pulmonary artery; and from the opposite side of the artery, to the second tendon of the *aorta*, there pass others, by both which the mouth of the pulmonary artery is dilated in the contraction of the heart. Under all these, some, which wind from the first tendon of the *aorta*, towards the point, when they come to the middle of the right ventricle, turn up again to the root of the pulmonary artery, or terminate in the fleshy pillars and *papillæ*. These both contract the ventricles, and dilate the arteries at the same time. The mouths of the ventricles are likewise surrounded with semi-circular fibres, which assist the valves in the systole of the heart; on the side of the *septum medium*, which is next the right ventricle, some fibres go straight from the basis to the *apex*. All the rest of the fibres are twisted only round the left ventricle, and of these some creep half way, some more than half way,
and

and then return to the basis by the opposite side; some again terminate in fleshy pillars and *papillæ*; the rest turn the point, and seem to me to involve the heart more than once in their going from, and returning to the basis. From hence it appears, that a much greater number of fibres involve the left ventricle than do the right; being the blood is by this thrust only through the lungs, but by that through all the parts of the body, even to the extremities, and back again. And that the force of the constriction of the ventricle might be every where strong, and the texture of the heart itself firmer, these fibres are not at all parallel, or they do not all run with the same obliquity, but the inner always decussate the outer, and frequently mix with one another. The bone which is found in the basis of the hearts of several beasts, is nothing but the tendons of the fibres of the heart ossified: It is sometimes found in men.

Of the sy-
stole and di-
astole of the
heart. This muscle has two motions; which they call *systole* and *diastole*. The *systole* is when the fibres of the heart contract, its sides swell, and its cavities are strongly pressed on all sides. The *diastole* is when this muscle ceaseth to act; its fibres are lengthened, its sides fall, and its cavities become large and wide.

Of the cir-
culation of
the blood
through the
heart. Having described the heart and its parts, let us now consider the circulation of the blood, which is performed by means of this muscle. The *vena cava ascendens* and *descendens* unite in one, and open into the right ear, where they unite; there is a lit-
tle

the protuberance made by their coats on the inside of the canal like an *isthmus*, which directs the blood both of the one and the other into the ear, and so hinders them from rushing one upon another. The right ear in its *diastole* receives the blood from the *vena cava*, which by its *systole* is thrust into the right ventricle; (for the tendinous circle, which is at the mouth of the *cava*, contracts and hinders the blood to return into it) which at the same time is in its *diastole*. In the *systole* of the right ventricle, the blood is thrust into the *arteria pulmonalis*, (for it cannot return into the ear, because of the *valvula tricuspides*), which communicates with the *vena pulmonalis*, which carries back the blood into the left ear, which in its *systole* thrusts the blood into the left ventricle, which is then in its *diastole*. In the *systole* of this ventricle the blood is thrust into the *aorta*, (for it cannot return into the ear, because of the *valvula mitrales*), which carries it through all the body. Now the *aorta*, when it comes out of the heart, ascends a little upward, and then turns downwards to form the descending trunk, for the reason already given; and from the upper side of this turning the cervical and vertebral vessels do arise; by this artifice the blood collides against the sides of the *aorta*; its force is broken, part of it is taken in by the mouths of the ascending branches, but its greatest part is directed downwards.

Let us now consider which way the blood circulates in the *fœtus*; for this you must observe, Of the circulation of the blood in the fœtus.

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observe, that in the right ear, on the lower side of the protuberance of the *cava*, just opposite to the mouth of the *cava ascendens*, there is a hole called the *foramen ovale*, which opens into the *vena pulmonalis*; this hole has a valve, which suffers the blood to enter the vein, but hinders it to come back again. There is likewise a passage or canal which runs from the trunk of the *arteria pulmonalis* to the trunk of the *aorta*.

Now the blood which comes from the *placenta*, by the umbilical vein, into the *vena portæ*, is sent into the *cava* by a canal which goes straight from the trunk of the *portæ* to the trunk of the *cava* in the liver. This ascends the *vena cava*, and is directly thrown through the *foramen ovale*, into the *vena pulmonalis*, which carries it into the left ventricle, which throws it into the *aorta*, to be distributed through all the body. But the blood which comes down the *vena cava descendens* is diverted by the isthmus of the *cava*, from the *foramen ovale*, and falls into the right ventricle, which thrusts it into the *arteria pulmonalis*, from whence part of it is immediately carried by the communicating canal into the *aorta*. The reason of these passages in a *fœtus* was, because the blood could not all pass through the pulmonary blood-vessels, they being too much compressed by the substance of the lungs; but as soon as the child is born, and the pressure is taken off from the blood-vessels, by the distention of the lungs with air, the blood finding a free passage through the lungs, runs no more by the commu-
ted

ted canal, whose direction likewise is not now so favourable for its reception as before; because the pulmonary artery being stretched out with the lungs, makes it go off at right angles, and therefore it dries up. And now the pulmonary veins being distended with the greater quantity of blood which it receives from the lungs, the valve of the *foramen ovale* is pressed close to its sides, denying a passage to the blood from the *cava*, to be mixed with the rest of the blood. By this you see, that the blood which comes from the *vena cava descendens*, passes only through the left ventricle, whilst the blood which comes from the *cava ascendens* passes only through the right ventricle.

From what has been said, it appears, that both auricles contract at the same time, as likewise do the ventricles; and that, when the auricles are contracted, the ventricles are dilated, *et vice versa*. To account for this alternate motion of the auricles and ventricles of the heart, we must consider that the contraction of all muscles is caused by the influx of the blood and animal spirits into the cavities of their fibres; and therefore, whenever this ceaseth, the contraction of the muscles likewise ceaseth, or, the swelling of the fibres abating, they may be reduced by any small force to the same length they were before their contraction, which alone is their natural state, the other being entirely caused by an external force. If therefore there be an equal and continual influx of the blood and animal spirits, the contraction of the muscles will likewise

be equal and continual; and, if the influx is unequal and interrupted, the contraction will be the same. What this influx is will best appear from the action of such muscles as have no antagonist, and over which our will has but a small influence; the most principal of which are the heart and the muscles which dilate the thorax in inspiration. Now both these are alternately dilated and contracted, and consequently the blood or animal spirits do not flow continually into their fibres, but at small intervals of time, to which these contractions answer. That they have no antagonist muscles, is evident to every one who is acquainted with the structure of the body; for the muscles, which, in a quick expiration, accelerate the motion of the ribs downwards, are so weak as to be of no moment; and that the pressure of the atmosphere upon the surface of our bodies cannot supply the place of antagonist muscles, as is apparent to any one who considers, that the air within us is always in *equilibrio* with the air without us, and consequently the pressure of the atmosphere can neither promote nor retard the contraction of the *thorax*, or the dilatation of the heart; and there being no other thing which can influence them, their alternate contractions and dilatation must be owing to the influx of the blood or animal spirits. There are indeed other muscles which have no antagonists, such as the *sphincter gulæ, ani*, and *vesicæ*, which we do not observe to be thus alternately relaxed and contracted; but the reason of this is, because
their

their force is very weak, and consequently their contraction small, and differing so little from their relaxation, as to be imperceptible to us; and perhaps, in the ordinary course of nature, they act no other ways than the fibres of the arteries do, which, when they are dilated by the blood, by their innate elasticity contract again. It may perhaps be objected, that, when one side of the face is struck with a palsy, the other is constantly and incessantly convulsed, and that therefore the influx of the blood and spirits must be continual. But to this I answer, that when the swelling which causeth the contraction of the fibres subsideth, and the muscles are relaxed, they will still be shortened, till, by some small power, they are pulled out to their natural length, which being here wanting, and one contraction presently following another, that side of the face will always appear as if incessantly convulsed. But the natural bent of the ribs is downwards, by which the intercostal muscles are stretched out again, as well as by the weak force of their few antagonists. And when the fibres of the heart are relaxed, they are, by the influx of the blood into the auricles and ventricles, distended again till the next contraction.

And that the muscles are not in a perpetual state of contraction, will likewise appear from the nature of the cause of their contraction, which without doubt is the rarefaction of the blood and spirits in the cavities of the muscular fibres. Now, of whatever nature we conceive this rarefaction to

be, it can be but temporary, and must quickly cease in such a small quantity of fluids, as the fibres of a muscle, or rather as one vesicle of a fibre is capable of receiving at a time. Nor will it be of any use to affirm, that there is a constant supply of fresh blood and spirits, which keep up the inflation of the fibres: for this inflation being caused by the pressure of the rarified fluids against the sides of the fibres; whilst this pressure continues, the progressive motion of the fluids through the fibres must be at a stop; nor can they move forward again, till the rarefaction begins to abate, that is, till the fibres are relaxed, and consequently the contraction or action of the muscle must cease, before fresh blood can be rarified. I have insisted the longer upon this point, because I think it has never been sufficiently cleared, and, if duly considered, it will be found of use in explaining some part of the animal oeconomy.

Being both blood and spirits are required for the inflation of the muscles, and that we are sure the blood moves with a continual stream, the animal spirits must only drop from the nerves into the muscular fibres, and there rarify the blood after the manner we have explained in speaking of muscular motion. When a drop falls, the fibres are presently inflated, and the muscle contracted; as soon as the rarefaction of the blood is over, the muscle is relaxed till the next drop falls from the nerves, by which it is contracted again. Thus the *systole* and *diastole* of the heart regularly and alternately follow

low one another; and, this being first clearly understood, it will be easy to give a reason why the auricles are constantly contracted when the ventricles are dilated, and the ventricles contracted when the auricles are dilated, notwithstanding they have all the same nerves and blood-vessels: for suppose all of them full of blood before the heart begins to beat, and that the auricles and ventricles are ready to contract at the same time, yet, because the strength of the ventricles is much greater than that of the auricles, they will contract; and by their contraction hinder that of the auricles, which endeavour likewise to expel the blood by which they are distended, but cannot perform it till the relaxation of the ventricles makes room for its reception. Thus their motions necessarily become alternate.

In the blood there is much volatile salt and spirits, some phlegm and sulphur, a little earth, but little or no fixed salt. Alcalies dissolve it, and acids coagulate it.

S E C T. V.

Of the Velocity and Quantity of the Blood.

HAVING shewed which way, and by what means the blood circulates through the heart, we shall next inquire with what velocity it moves.

The ventricles of the heart are each capable of receiving an ounce of blood, or more; and therefore, being full in their *diastole*,

astole, we may suppose, that they throw out at least one ounce of blood each *systole*. The heart contracts about 4000 times in an hour, more or less, according to the different temperaments, sexes, and ages; and therefore there passes through the heart every hour 4000 ounces, or 250 *lib.* weight of blood. Now the common opinion is, that the whole mass of blood does not exceed 25 *lib.* and therefore, according to this allowance, a quantity of blood equal to the whole mass passes through the heart 10 times in an hour, that is, about once every six minutes. If the heart contracts 80 times in a minute, then 25 *lib.* weight of blood passes through its ventricles once in five minutes, or twelve times in an hour.

Now having the number of pulses in any determinate time, the quantity of blood thrown out at the left ventricle of the heart every pulse, and the diameter of the *aorta*, it will be easy to find with what degree of celerity the blood moves through the *aorta*: *For the celerity with which a fluid runs out at any orifice, uniformly, and always running in the same quantity, is equal to the velocity of a body, which describes a space of the same length with that of a cylinder, whose basis is equal to the orifice, and whose magnitude is equal to the quantity of the fluid that runs out in the same time.* Now suppose the heart contracts 80 times in a minute, and that each *systole* throws into the *aorta* an ounce of blood, which is equal in bulk to 1,659 inches, and consequently 80 ounces are 132,72 inches. The diameter of the *aorta* I have

have found to be 0,73 parts of an inch, and therefore its orifice is 0,4187, by which if 132,72 be divided, the quotient 316 inches, or 26 feet, gives the length of a cylinder, or the space through which the blood moves in a minute, supposing it were constantly going out of the heart with the same velocity: but because of the diastole of the heart, which is at least half the time of a pulsation, there goes out 80 ounces in half a minute; and consequently the velocity of the blood is double, or it moves at the rate of 52 feet in a minute.

Now, because the sum of the sections of the branches of an artery is always greater than that of the trunk, the velocity of the blood must constantly decrease as the artery branches. The exactest proportion of the branches to their trunks which I have lately found by measuring an artery of the thigh, injected with wax, by that excellent anatomist Mr. Cowper, is as 12,387 to 1000; and consequently, from what I have elsewhere demonstrated, the greatest velocity of the blood will be to the least as 5233 to 1, or the blood moves 5233 times slower in some capillary arteries than it does in the *aorta*.

The blood is received from the arteries into the veins, where it still moves slower as it returns to the heart again. The arteries are to the veins as 324 to 441, and consequently the blood moves in the veins above 7116 times slower than it does in the *aorta*.

The farther the blood moves from the heart, the slower it returns; and all the blood, which at the same time is thrown out
of

of the heart, does not return at the same time to it again, but the times are directly as the spaces the blood runs over before it returns to the heart again, and reciprocally as the velocities; and consequently some parts of the blood may be some thousand times longer in returning to the heart than others, and there is no time when all the blood can be said to have only once circulated.

But, if there were any such time, the quantity of the blood in the body must be first determined, which I do not find to be agreed upon by authors, some affirming that there is but 10, others 15, 20, and 25 pounds weight of blood in the whole body. It is a very difficult thing, if at all possible, to determine the just quantity of blood in any animal body. That bleeding to death can never give any estimate which shall be near to the true quantity, is almost demonstration; for no animal can bleed longer than the great artery keeps full, which will be a longer or shorter time, as the artery wounded is smaller or greater, and the *aorta* must always be the first vessel that empties.

The only way that I know, by which we can come to a nearer knowledge of the quantity of the blood, is by finding what proportion the cavities of the vessels (of which the whole body is composed) bear to the thickness of their coats. This in the veins and arteries may be exactly found; but in the other vessels we only know the quantity of fluids they contain, by carefully evaporating

evaporating as much of their fluids as we can.
Thus I find the fluids are to the vessels.

$$\text{In the } \left\{ \begin{array}{l} \text{Arteries,} \\ \text{Veins,} \\ \text{Muscles,} \\ \text{Nerves,} \\ \text{Bones,} \end{array} \right\} \text{ as } \left\{ \begin{array}{l} 1, 7 \\ 15, 6 \\ 3, 6 \\ 3, \\ 1, \end{array} \right\} \text{ to 1.}$$

The result of these proportions shews the liquors to be one half of the weight of the body: and if we calculate upon the proportion of the blood in the arteries, to their coats, in a body weighing 160 pound, there will be found 100 pounds of blood. In this calculation I have comprehended all the liquors in the body; but all of them, besides the blood, have been generally thought of so small a quantity, that the whole body has always passed for solid, excepting the blood: and indeed, all the fluids in the body are either blood or parts of the blood, moved by the force of the heart, contained in vessels continued from the arteries, and as useful to life as the blood; and therefore I think in this inquiry not to be distinguished from it. And whoever would make a right judgement of the strength of the heart, must calculate the quantity of all the fluids moved by it; or whoever would form a right idea of the animal oeconomy, must know the quantity of all the useful fluids, as well as of the blood. And must not our idea of it, when we consider the body as composed mostly of fluids, be very different from that which a body, consisting mostly of solid parts,

parts, and not above one tenth part fluid, gives us ?

S E C T. VI.

Of the Lungs.

Of the figure
of the lungs.

THE *lungs* are in the middle of the cavity of the *thorax* ; they are divided into two lobes by the *mediastinum* ; and the left is ordinarily subdivided into two more. The figure of both *lobes* together resembles a cow's foot, being a little concave betwixt the two lobes, where they embrace the heart, and behind where they ly upon the *vertebræ* ; but before, where they touch the *sternum* and ribs, they are convex. The colour of the *lungs* in a *fœtus* is of a pale red ; but, after the air has once entered them, they lose their red, and remain always pale ; yet in adults they are variegated with the one and the other. They are tied to the *sternum* by the *mediastinum* before, to the *vertebræ* by the *pleura* behind, where it rises from the *vertebræ* to the heart by the *vena* and *arteria pulmonalis*, and sometimes to the *pleura* where it covers the ribs, particularly in the left side, and especially after a pleurisy.

Of the
membranes
of the lungs.

The *lobes* of the *lungs* are covered with a double membrane ; the external is a production of the *pleura* ; the internal not only covers immediately the substance of the *lungs*, but its inner *lamina* fills up the interstices which are between the bunches of the

the small lobes with little vesicular cells: The fine capillary blood vessels are so thick upon this membrane, that it seems to be nothing but a net-work of *veins* and *arteries*.

The substance of the *lungs* is composed of an infinite number of little lobes of various figures and magnitudes; but their surfaces are so adapted to one another as to leave but very few and small interstices. These lobes are disposed like so many bunches of grapes upon the sides of the *bronchi*. Each little lobe contains within its own proper membrane, an infinite number of small and little orbicular vesicles, which leave small interstices between them, which are full of small membranes, like those which tie the lobes together. The extremities of the branches of the wind-pipe open into the cavities of the vesicles, which are probably formed by its membranes; but the capillary blood-vessels are only spread upon the vesicles like a net, with frequent and large inosculation.

Of the structure of the lungs.

Now the vessels which enter the lungs, are the *trachea* or *aspera arteria*, by which we draw in the air; the *arteria pulmonalis*, which comes from the right ventricle; and *vena pulmonalis*, whose trunk opens in the left auricle of the heart: each of these divides into two branches, for the two great lobes of the *lungs*, where they are sub-divided into as many branches as there are little lobes or vesicles in the *lungs*. Where-ever there is a branch of the *trachea*, there is a branch of the vein and artery; and the *trachea* is

Of the vessels of the lungs.

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always

always in the middle. Upon the branches of the *trachea arteria*, which are called *bronchi*, run a small artery, called (by Mr. *Ruisch*) *arteria bronchialis*, a small vein, which *Sommichellius* calls *vena pneumonica*. The artery comes from the *aorta*, and the vein opens into the subclavian. Upon the *bronchi*, even to their minutest ramifications, run likewise the finest threads of the eighth pair of nerves. Besides these, the lungs have lymphatics, which discharge themselves into the thoracick duct; but they are smaller, and make more frequent inosculation than I have observed any where else.

Of the trachea arteria.

This is the passage of the vessels thro' the lungs; but, because the *trachea arteria* has a particular structure, it demands a particular examination. It has a canal situated in the fore part of the neck, before the *oesophagus*; its upper end is called *larynx*, from whence it descends to the fourth *vertebra* of the back, where it divides, and enters the

Of its cartilages.

lungs. This canal is made of annular cartilages, which are at small and equal distances from one another. These cartilages grow smaller and smaller, as they approach the lungs; and those of the *bronchi* are so close to one another, that, in expiration, the second enters within the first, and the third within the second, and so the following always enters the preceding. Betwixt the *larynx* and the lungs, these cartilages make not compleat rings; but their hind part, which is contiguous to the *oesophagus*, is membranous, that they may the

the better contract and dilate, and give way to the aliments as they go down the *œsophagus*. But the cartilages of the *bronchi* are compleatly annular; yet their capillary branches have no cartilages, but, instead of them, small circular ligaments, which are at pretty large distances from one another. The use of the cartilages is to keep the passage for the air always open; but in the capillary *bronchi* they would hinder the subsiding of the vesicles.

These cartilages are tied together by two Of its membranes. membranes, the one external, and the other internal. The external is composed of circular fibres; it covers the whole *trachea* externally. The internal is of an exquisite sense; it covers the cartilages internally. It is composed of three distinct membranes: the first is woven of two orders of fibres. Those of the first order are longitudinal; for the shortening the *trachea*, they make the cartilages approach and enter one another. The other order is of circular fibres, for the contracting of the cartilages. When these two orders of fibres act, they help, with the external membrane, in expiration, in coughing, and in altering the note of our voice. The second membrane is altogether glandulous, and the excretory vessels of these glands open in the cavity of the *trachea*; they separate a liquor for the moistening the cavity, and for defending it from the acrimony of the air. The third and last is a net of *veins*, *nerves*, and *arteries*. The *veins* are branches of the *vena cava*; the *nerves*

of the *recurrent*; and the *arteries* of the *carotides*.

Of the use of the lungs. From the structure of the *lungs* thus explained, the learned *Pitcairn* has mechanically deduced the great effect they, by means of the air, produce upon the blood. For, whilst the *fœtus* is in the womb, the vesicles of the *lungs* lying flat upon one another, compress all the capillary blood-vessels which are spread upon them: but as soon as we are born, the air, by the dilatation of the *thorax*, is thrust into the branches of the *trachea arteria*, and blows up the vesicles into spheres; by which means the compression being taken off from the blood-vessels, and they equally expanded with the lungs, all the blood has a free passage thro' the pulmonary artery. But when the air is thrust out again by the contraction of the cavity of the *thorax*, it being a fluid body, compresses the vesicles and blood-vessels upon them every where equally. By this compression, the red globules of the blood, which, through their languid motion in the veins, were grown too big to circulate in the fine capillary vessels, are broken and divided again in the *serum*, and the blood made fit for nutrition and secretion. This pressure of the air upon the blood-vessels may be demonstrated to be equal to 100 pound weight; and, in coughing, or crying, it may exceed 400 pound.

But though these are the necessary consequences of respiration, yet several experiments incline me to think, that some particles of the air must likewise enter the blood.

blood vessels, and mix with the blood in the *lungs*. For, first, I am assured, from repeated experiments, that air will escape through the pores of any number of bladders, when compressed only by the weight of the water into which it is sunk; and therefore the pressure of 100 pound weight, in ordinary respiration, must thrust some particles of it into the blood-vessels. Secondly, the Honourable Mr. Boyle, in his new *Pneumatical Experiments*, shews us, that animals cannot live when shut up in common air, though, by a gage he has found it to retain its wonted pressure, and though the receiver has been immersed in water, cooled with a solution of sal armoniack. The same *Experiments* assure us, that animals will live longer shut up in compressed air, than in common air; and that, when they are dying in the common air, they may be revived by pressing in more fresh air. What Mr. Boyle says, I have likewise experienced to be true, with this difference, that as the animal shut up in uncompassed air grew weak, so the mercury in the barometer (which was used for a gage) sunk; and when the animal died, it had fallen near one third of an inch, and therefore it is plain, that the pressure or elasticity of the air was diminished by the animal; and when the animal was dead, the air by degrees recovered its former pressure, and raised the mercury to the same height as before; though I am sure there was no communication with the external air, having tried the experiment more than once. What other

account can be given of this, but that the animal did suck in some of the elastick particles of the air, which, when dead, were emitted again? All which, I think, do sufficiently prove, that the air does mix with the blood in the lungs. Lastly, it may be demonstrated, that the difference between the gravity of the air in the city, and that of the country, (which can be but very small upon the account of the *effluvia*, as the barometer shews it to be) can never be the cause of that difficulty of breathing, which some have in the one, and not in the other; for they are not near so sensible of the different gravities of the air in the same place, as they are of a much smaller difference in two distinct and remote places, where the contents of the air are different.

S E C T. VII.

Of the Larynx.

Its situation.

THE upper end of the *trachea arteria* is called the *larynx*. It lies below the root of the tongue, before the *pharynx*. It is composed of five cartilages, which sometimes, in old men, become as hard as bones.

Of the cartilago scutiformis.

The first is the *thyroideus*, or *scutiformis*, because of its figure. It makes that protuberance in the fore part of the *larynx* called *pomum Adami*. It is a thin cartilage about an inch broad, but not so long. It is concave within, and convex without. Its

four

four angles have each a small production; the two upper, which are longer, are tied to the horns of the *os hyoides*, and the two lower to the second cartilage, which is called *κρικουσιδης*, or *annularis*, because it resembles a ring. It is very large and thick behind, which part is like the stone of a ring, and it grows narrower to its fore part; and it is situated below the other cartilages of the *larynx*; they stand upon it as upon a basis, and by it they are tied to the *trachea*.

Of the annularis.

The third and fourth are alike, and have one common name, which is the *αγυλαινοιδης*. They reach from the middle of the concave side of the *thyroides* to the upper and back part of the *annularis*, and they make that chink, or *rimula*, which is the mouth of the *larynx*, called *glottis*. Betwixt those and the sides of the *thyroides*, there are two small cavities on each side, formed by the muscles and membranes which join them together; in which, if a little drink or bread fall, as sometimes it happens when one laughs or speaks, in eating or drinking, it causes a violent cough, and a great tickling.

The fifth and last cartilage is the *epiglottis*; it is of a softer substance than the others; it resembles a little tongue; it is tied by its basis to the upper and middle part of the concave side of the *thyroides*: its use is to cover the *glottis* in eating and drinking; for the aliments, by their weight, press it close down upon the *glottis*, and they pass over, without entering the *larynx*, into the *oesophagus*: but when the aliments are past, the

Of the epiglottis.

the *epiglottis*, by its natural retort, which is common to all cartilages, lifts up again, and gives way to the air in breathing. When we speak or laugh, the *glottis* must necessarily be open for the passage of the air; therefore it is not convenient to speak whilst we swallow.

Of the muscles of the larynx.

Sternothyroides.

The *larynx* has two pair of common muscles, and five pair proper.

The first of the common muscles is the *sternothyroides*; it arises from the upper part of the inside of the *sternum*, and ascending on the sides of the *trachea arteria*, it is inserted to the lower part of the sides of the *cartilago scutiformis*: when these muscles act, they pull this cartilage downwards.

Hyothyroides.

The second is the *hyothyroides*; it arises from the lower part of the *os hyoides*, and descending, is inserted into the lower part of the *scutiformis*, near the former: they pull up the *larynx*.

Cricothyroides.

The first of the proper muscles is the *cricothyroides*; it arises from the fore part of the cartilage *cricoides*, and running under the *thyroides*, it is inserted into the inside of that cartilage.

Cryco-arytænoides.

The second is the *cryco-arytænoides lateralis*; it arises from the lateral part of the *cricoides*, and ascending, is inserted into the lateral part of the *arytænoides*; this dilates the *arytænoides*.

Cryco-arytænoides posticus.

The third is the *crico-arytænoides posticus*; it ariseth from the back part of the cartilage *cricoides*, and is inserted into the *arytænoides* near the former.

Thyro-arytænoides.

The fourth is the *thyro-arytænoides*; it ariseth

ariseth from the internal and concave side of the *scutiformis*, and is inserted into the fore parts of the *arytænoides*; it contracts the *rimula*.

The fifth muscle is the *arytænoides*; it runneth upon the upper part of the cartilage *arytænoides*, and, with its fellow, forms a sphincter for contracting of the *rimula*. Arytænoides.

A true squinzie, which is caused by the inflammation of these muscles, is generally mortal; because they shut exactly the chink of the *larynx*: therefore *bronchotomy* is absolutely necessary in this case, but it is rarely though it may be safely used.

The *larynx* receives veins from the *jugulars*, arteries from the *carotides*, and nerves from the *recurrent*. Of the vessels of the larynx.

On the lower part of the *larynx*, upon the sides of the annular cartilage, and of the first ring of the *trachea*, there are two lymphatick glands called *thyroideæ*, of the figure of a pear; their colour is red; they have veins, nerves, and arteries, as the *larynx*. Of the glands of the larynx.

The use of the *larynx* is not only to form the voice, but also, by the different apertures of its *rimula*, the lungs are more or less compressed by the air; for, if the aperture of the *larynx* had been as wide as the *aspera arteria*, the lungs could have suffered little or no compression.

Had it not been for the *larynx*, we could have received no benefit by breathing; for, if the mouth of the *aspera arteria* had been large and wide, the air had not resisted that force by which it is thrust out in expiration, so

so as to make any compression upon the lungs, whereby the globules of the blood could have been dissolved, or the particles of both fluids mixed together, which we find so necessary to life, that we die without it. Nor does the *larynx* only preserve life, but it likewise conduces to render it happy and agreeable, by forming the voice, which is the sound of the air drove through the narrow chink of the *glottis*, with a velocity greater than in an ordinary expiration. This sound is increased by the cavities of the mouth and nose, which resound like the hollow of a violin, as is evident by the trembling to be felt in the nose while we speak. And these cavities not only encrease, but also conduce to the agreeableness of the voice; for how disagreeable is the alteration of the voice, which follows a loss or stoppage of the nose? and the dimensions of the mouth are always proportioned to the notes formed in the *glottis*, low notes being constantly accompanied with a promulgation, and high notes a contraction of its cavity. The notes themselves are formed by the different apertures of the *glottis*: For, when the *glottis* is contracted, the air being drove with an equal force, must move more swiftly; and the sides of the *glottis* being more tense, their vibrations must be quicker and shorter, and consequently the note high. The contrary happens when the *glottis* wideth.

Each note is capable of all degrees of strength; for the strength of the voice is always proportionable to the quantity of air thrown out of the *larynx*, in sounding of the same

same note. Now, if the strength of the note is to be increased, the *diaphragma*, but more especially the muscular fibres of the *trachea arteria*, contract more strongly, and thrust out a greater quantity of the air; and the aperture of the *glottis* encreases proportionally, that this greater quantity of air may pass through with the same velocity as before, that the same note may be continued.

Now supposing the greatest distance of the two sides of the *glottis* to be one tenth part of an inch in sounding of 12 notes (to which the voice easily reaches) this line must be divided into 12 parts, each of which gives the aperture requisite for such a note, with a certain strength. But, if we consider the subdivision of notes into which the voice can run, the motion of the sides of the *glottis* is still vastly nicer; for if two chords sounding exactly unisons, one be shortened one seven thousandth part of its length, a just ear will perceive the disagreement, and a good voice will sound the difference, which is one hundred and ninety sixth part of a note. But, because this is a great nicety, I shall only suppose that the voice can divide a note into a hundred parts, from whence it follows, that the different apertures of the *glottis* actually divide the tenth part of an inch into one thousand and two hundred parts, the effect of each of which produces a sensible alteration upon a good ear. But because each side of the *glottis* moves just equally, therefore the divisions are just double; or the sides of the *glottis*, by their motion, do actually divide one tenth part of an inch into two thousand four hundred parts.

CHAP.

C H A P. IV.

Of the upper Cavity, or Head.

S E C T. I.

Of the Frontal and Occipital Muscles ; and of the Pericranium.

THE head is situated in the upper part of the body, not only for the convenience of the senses, but also that the brain may the more easily send the animal spirits to all the parts of the body.

Its natural figure is round, but a little flat upon its sides ; round, that it might contain the greater quantity of brains ; and flat upon its sides, that the bounds of the sight may be the larger, or rather that the ears might not be too much exposed to danger.

We have divided the external parts of the head into two, the face and the hairy scalp ; we shall now divide it into the *containing* and the *contained* parts. The containing parts are the skin with the hair upon it, the *pericranium*, the skull, and the two *meninges*. Of the skin and hair we have already spoken ; of the skull we shall speak in its proper place.

Anatomists do generally say, That the skull is covered both with a *pericranium* and a *periosteum* ; but they have taken the *aponeurosis* of the occipital and frontal muscles

for one of them. These muscles ly immediately under the skin. The first two are called *frontales*. Their fleshy fibres are inserted into the eye brows; from thence they go strait up the *os frontis*, and are continued by a long and large *aponeurosis* to that of the *occipitales*; they adhere closely to the skin of the forehead, which they pull upwards. The other two muscles, which are called *occipitales* have their fleshy fibres fixed to the skin of the hind head, which they also pull upwards: they are short, broad, and thin; and they end in a large *aponeurosis*, which joins that of the frontals, and both together cover the whole skull.

Therefore the *periostæum* or *pericranium* Of the pericranium. is a very thin and nervous membrane, of an exquisite sense, which covers immediately not only the *cranium*, but all the bones of the body, except the teeth. It is tied to the *dura mater* by some fibres which pass through the sutures of the skull. It receives veins from the external jugulars, arteries from the *carotides*, nerves from the fifth pair of the brain, and from the second of the neck.

S E C T. II

Of the Dura and Pia Mater.

THE membranes, or *meninges*, which are within the *cranium*, are two, the *dura mater* and the *pia mater*; so called,
 M because

because they are supposed to be the origination of all the membranes of the body.

Of the dura mater.

The *dura mater* is a strong and thick membrane, which covers all the cavity of the *cranium*; it contains the whole brain somewhat loosely, that the vessels which run between its duplicature, and upon the surface of the brain, be not too much pressed by the *cranium*; it sticks very close to the basis of the *cranium*, and to its futures, by the fibres and vessels it sends to the *pericranium*; it is fastened to the *pia mater*, and to the brain, by the vessels which pass from the one to the other. It gives a coat or covering to all the nerves which rise from the brain, to the *spinalis medulla*, and to all the nerves which rise from it. Its surface is rough towards the *cranium*, but smooth towards the brain. It is a double membrane woven of strong fibres, which may be plainly seen on its inside, but very hardly on its outside next the *cranium*.

Of its processes.

The *dura mater* hath three processes made by the doubling of its inner membrane. The first rises by a narrow beginning from the *crista galli*, to which it is fastened; and, as it approaches the hind part of the head, it grows broader and broader, till it terminates where the longitudinal *sinus* ends. It divides the *cerebrum* into two hemispheres, near as deep as the *corpus callosum*. It resemble a sickle, therefore it is called *falx*. The second separates the *cerebrum* from the *cerebellum* down to the *medulla oblongata*, that the weight of the *cerebrum* may not offend the *cerebellum* which lies under it; this process

cess is very strong and thick, and in ravenous beasts it is for the most part bony, because of the violent motion of their brain. The third is the smallest; it separates the external substance of the hinder part of the *cerebellum* into two protuberances; and upon it Monsieur Du Verney's fifth *sinus* runs.

In the *dura mater* there are several *sinuses*, Of the sinuses of the dura mater. or channels which run between its external and internal membrane; of these there are four principal ones which are commonly described.

The first is the *sinus longitudinalis*; it rises First of the longitudinalis. from the blind hole in the upper part of the *crista galli*; it runs along the upper part of the *falx*, and ends where it ends: it lies exactly under the *sutura sagittalis*. Into this *sinus* the veins of the brain, and some of the proper veins of the *dura mater*, bring back the blood which they receive from the arteries. Of these veins, some running obliquely from the fore part of the brain backwards, and others contrary from the hind part forward, creep a little space between the duplicature of the membrane, as the ureters do upon the bladder, and so they open in the *sinus*. In this *sinus* there are several small cells and round ligaments which go from one side of the cavity to the other. These, by their elasticity, further the motion of the blood.

The second and third *sinuses*, which this *sinus* pours into, are the *laterales*; Laterales. they rise from the end of the first, into which they open, and going down upon the sides of the occipital bone, in a crooked way, they pass

through the same hole with the eighth pair of nerves, and discharge them into the internal jugulars. Into these *sinuses* some veins and the other *sinuses* discharge themselves.

Of the fourth sinus.

The fourth *sinus* runs by the broad extremity of the *falx*, and opens where the lateral *sinuses* join the longitudinal. This meeting of the four *sinuses* is called *torcular*. It receives the blood at its other extremity, from the *plexus choroides*.

Of the sinus superiores.

Besides these, there are six more, which have been described by several anatomists. The first two are called *superiores*; they rise from the hinder processes of the *sella turcica*, or from the *circular sinuses* of Dr. Ridley, and run along the upper part of the internal processes of the *os petrosum*; then descending, they open into the *laterales*.

Of the inferiores.

There are two more, called *inferiores*; they rise from the same place with the other two, and running upon the union of the *os petrosum* with the occipital, they open into the *laterales*, just as they are going out of the skull.

A fifth sinus.

There is a fifth, which the curious Mr. Du Verney demonstrates; it runs upon the third process of the *dura mater*, and divides into two branches, of which one opens into the *laterales*, and the other into the *sinus vertebrales*. That exact anatomist Dr. Ridley, in his Treatise of the Brain, gives ac-

Of the circular sinus.

count of a sixth, which he calls the *circular sinus*, because it surrounds the *glandula pituitaria*; it communicates with the two *superiores* and *inferiores*.

Vesalius

Vesalius hath remarked a *sinus* which runs along the bottom of the *falx*, and which opens into the fourth *sinus*; this is called by Mr. Du Verney, *longitudinalis inferior*. There are two more situated at the second process of the *dura mater*, one on each side; they are about an inch wide from the *laterals*, into which they open; but these three do not always appear.

Of three
other
sinuses.

The use of these *sinuses* is to receive the blood of the adjacent parts from the veins, to which they are as so many trunks which discharge the blood into the internal jugulars.

The use of
the sinuses.

The vessels of the *dura mater* are, first, a branch from the *carotidal*, whilst it is in its long canal, which is dispersed in the fore and lower part of the *dura mater*. Secondly, an artery which enters the hole of the *cranium*, called *foramen arteriæ duræ matris*; it is dispersed on the sides of this membrane, and runs as high as the *sinus longitudinalis*: the vein which accompanies the branches of this artery goes out of the skull by the *foramen lacerum*. Thirdly, a branch of the vertebral artery and vein, which last passes through the hole behind the occipital apophysis; they are dispersed in the hind part of the *dura mater*.

Of the vessels of the
dura mater.

The blood which is brought by the arteries, is carried back by the veins which go out of the same holes by which the arteries enter: but in case the swelling of the arteries, by a preternatural fermentation of the blood, should compress the veins as they go out of the skull; which might easily happen,

being it has more arteries than veins: therefore there are several other veins, which interoscute with the arteries, and which carry the blood from them into two small veins, which are on the sides of the longitudinal *sinuses*. It is these veins which open into this *sinus*, that the blood which was stopped the other way, may have a free circulation this way, as has been ingeniously observed by Dr. Ridley

It has also nerves from the first branch of the fifth pair, which give it an exquisite sense. It has a motion of *systole* and *diastole*, which is caused by the arteries which enter the skull. No doubt the great number of arteries in the brain contribute more to it than those few proper to itself, which may assist a little, though not very sensibly, because of their smallness and paucity. The use of the *dura mater* is to contain and cover the brain, the spinal marrow, and all the nerves, to divide the *cerebrum* in two, and to hinder it from pressing the *cerebellum*.

Of the pia mater.

The *pia mater* is a thin and delicate double membrane, which lies under the *dura mater*, and covers immediately the substance of the brain. Its inner membrane is much larger than its outward membrane; for it runs in betwixt all the foldings and circulations of the brain, to separate them, and to sustain the blood-vessels, which make several turnings and windings upon it, before they terminate in the substance of the brain. It has the same use as the *dura mater*.

S E C T. III.

Of the Cerebrum and Cerebellum.

THE whole substance of the brain is The brain divided into two. divided into two parts; that which lies mostly on the fore part of the skull is properly called the *cerebrum*; and that which lies in the back part, under the hind part of the *cerebrum*, (which is supported by the second process of the *dura mater*) is called the *cerebellum*. Both the one and the other are contained in the *meninges*, and in the *cranium*, as in a case of bones, that nothing may hurt their substance, which is soft.

The *cerebrum* is of a round figure; it is Of the figure and substance of the cerebrum. divided by the first process of the *dura mater* into the right and left side. Its external surface resembles the turnings and windings of the intestines. In the *cerebrum* we distinguish two different substances; the external, which is of an ashy colour; and the internal, which is of a white colour. Its external substance is called *substantia corticalia*, or *fineracea*; it is soft, glandulous, and of the colour of ashes. Its internal, called *substantia medullaris*, is firmer, white, and fibrous; of it the nerves are made, and it reaches to the extremity of the *medulla spinalis*, where it divides into fibres.

The external substance of the brain, by its circumvolutions, resembles the small guts; and in the middle of each circumvolution

lution is the beginning of the medullary substance: so that the cortical substance is always on the external side: and the inner *lamina* of the *pia mater* is co-extended with the cortical substance, which it immediately covers every where.

Malpighius, who has examined this cortical substance, says, that it is nothing but a heap of little oval glands, which receive the capillary branches of the veins and arteries which belong to the brain, and which send out an infinite number of fibres which all together make up the medullary substance, which, going out of the *cranium*, forms the nerves and *medulla spinalis* contained in the *vertebræ*.

A general idea of the structure of the brain;

The internal substance of the right and left side of the brain coming to join one another, leave a space between them, which forms the three ventricles, or *centrum ovale*; the upper part or covering of this space is called the *corpus callosum*; the bottom of this space is the internal substance of the two sides of the *cerebrum*, gathered together, as it were, in two bundles, which are called *crura medullæ oblongatæ*; upon them are the protuberances called the *corpora striata*, and the *thalami nervorum opticorum*. These *crura* uniting make one body, called the *medulla oblongata*, upon which there are four prominences called *nates* and *testes*: and behind these prominences, the internal or medullary substance of the *cerebellum* being also divided into two bundles, forms upon each side of the *medulla oblongata* three more protuberances; and then it passes out of the
cranium

cranium into the *vertebræ*, where it gets the name of *medulla spinalis*. This is a general idea of the structure of the brain, for the better understanding its parts: which we shall now describe in particular.

Below the depth of all the circumvolutions of the brain, the first thing that appears immediately under the first process of the *dura mater* is the *corpus callosum*, or the covering of the two lateral ventricles, formed by the union of the medullary fibres of each side.

This being laid aside, the two lateral ventricles appear; they reach from the fore part of the *cerebrum* backwards; they are pretty broad in their hind part, but they grow narrower towards their fore part. They are divided into the right and left ^{Of the two} ventricle by a thin transparent membrane, ^{ventricles.} which comes from the under side of the *corpus callosum*, and is extended to the *for-nix*, which is in the bottom of the ventricles; this membrane is called *septum lucidum*. I am apt to think it is a production of the *pia* ^{Of the sep-} ^{tum luci-} ^{dum.} *mater* which covers all the sides of the ventricles.

In these two ventricles there are four prominences, two in each ventricle.

The foremost two are called *corpora striata*. ^{Of the cor-} ^{pora striata,} which are the tips of the *crura medullæ oblongatæ*. They are oblong, and their extremities come down upon the sides of the two other prominences: they are of a cineritious colour without, but in their internal substance there are many white streaks, which are the medullary substance mixed with.

with the cineritious or glandulous. They are, as it were, tied together by a medullary process, called (by *Vicussius*) *commiffura crassioris nervi æmula*.

Of the thal.
nerv. opt.

The two other prominences are called *thalami nervorum opticoꝝ*, because the optick nerves rise out of them; they are medullary without, but a little cineritious within; they are of an oblong figure; they are upon the upper part of the *crura medullæ oblongatæ*: between them there is a medullary tract, which encompasses them, called (by Willis) *limbi posteriores corporum striatorum*.

Of the plexus
choroides.

Upon them also lies the *plexus choroides*, made of veins, arteries, and little glands. Dr. Ridley says, he has seen lymphaticks rise from it. This *plexus* reaches from one lateral ventricle to the other, passing under the *fornix*, above the third ventricle. It sends a branch to the fourth *sinus* of the *dura mater*.

Of the fornix.

In the middle, above the *corpora striata* and the *thal. nerv. opt.* there lies a thin and broad production of the medullary substance, which comes from the fore part of the ventricles by two roots, and reaches to the hinder part, where it ends by two other protuberances called *is crura*, which cover a great part of the *thal. nerv. opt.* This production is called the *fornix*, because it is a covering to the third ventricle.

Of the third
ventricle.

Under the *fornix* there is a *rima* between the *crura medullæ oblongatæ*, which is the third ventricle, it being a little dilated in its fore part: there is a hole that goes down to the *glandula pituitaria*; this hole is the entry.

entry to the *infundibulum*, or funnel, so called because of its figure. It has a small conduit made of the medullary substance covered with the *pia mater*; it pierces the *dura mater* upon the basis of the skull, and sinks into the substance of

The *glandula pituitaria*, which is situated in the *sella turcica* closely covered with the *pia* and *dura mater*; it is of a harder substance than the other glands of the body; it receives the end of the *infundibulum*, which carries a liquor from the ventricles into this gland, which is surrounded by the *rete mirabile*, or a *plexus* of some branches of the *carotid* and *cervical arteries*, which break the *impetus* of the blood, and abate the velocity, as it passes through the tender substance of the brain.

But to return to the third *ventricle*. In its hinder part there is another small hole, called *anus*, which leads into the fourth *ventricle* in the *cerebellum*. In the upper part of this hole is situated the *glandula pinealis*, (Des Cartes's pretended seat of the soul) about the bigness of a pea; it is composed of the same substance with the rest of the brain, and for the same use. It is tied by some fibres to the

Nates, which are two prominences of the *medulla oblongata*, situated above the fore part of the conduit, which leads from the *anus* to the fourth *ventricle*; they are of an oval figure, pretty big; and immediately behind them are two other prominences of the same figure and substance called *testes*, both covered with a net of blood vessels.

There

There is a small transverse medullary protuberance behind the *testes*, from which the *pathetick nerves* rise.

Isthmus.

Valvula
major.

Cerebellum.

Processus
vermiformes.

The conduit which reaches from the *anus* to the fourth *ventricle*, is in that part of the *medulla oblongata*, which is betwixt the *cerebrum* and the *cerebellum*, called the *isthmus*. The upper part, or cover of this conduit, which is betwixt the *testes* and the foremost vermicular process of the *cerebellum*, to which two it is tied at its two ends, and to the processes that come from the *cerebellum* to the *testes*, at its sides, is called *valvula major*: it is of a medullary substance; its use is to keep the *lymph*a from falling out above the nerves in the basis of the skull. These are all the parts belonging to the *cerebrum*.

Now the *cerebellum*, which is much less, is also composed of a cortical and medullary substance; its superficies makes not turnings and windings as that of the *cerebrum*; but its foldings are strait, and they resemble the segments of circles, or the edges of plates laid in one another; and these segments are largest in its middle, and they grow less as they approach its fore and hind part; where they seem to resemble two worms, therefore called *processus vermiformes*.

The medullary substance of the *cerebellum*, as it approaches the *medulla oblongata*, gathers together, and then divides equally into two bundles, which are joined to the two sides of the *medulla oblongata*: as they separate, they leave a little space upon the

upper side of the *medulla*, which is called the fourth *ventricle*; and its farther end, because of its resemblance, *calamus scriptorius*. The top of this *ventricle* is covered with several blood-vessels woven like a net.

The medullary substance of the *cerebellum* makes three processes upon each side of the *medulla oblongata*. The first two go on each side of it to the *testes*; the *valvula major* is betwixt them. The second two are pretty broad; they go straight down on each side, and meet on the under side of the *medulla*; they make that protuberance called *processus annularis*. And the third goes backwards upon the upper sides of the *medulla*; they make it look bigger, being like two cords upon its sides.

This is all that is remarkable in the *cerebrum*, *cerebellum*, and upper side of the *medulla oblongata*. But if you turn over the brain, you may see distinctly the rise of all the nerves, the *infundibulum*, two white spots behind it, the *crura medullæ oblongatæ*, one on each side of the *cerebrum*. Where they join, you may see the *processus annularis*, or *pons varolii*: and beyond that, there are two prominences called *corpora pyramidalia*; they are about an inch long; and on each side of them, towards their lower end, there are two more, which, because of their figure, are called *corpora olivaria*; and then the *medulla oblongata* goes out of the skull, being contained in the *pia* and *dura mater*.

Observe, that the *medulla oblongata*, with all the protuberances which are upon its up-

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per and lower sides, are not purely of the medullary substance, but internally they are mixed with the cortical; and it is this mixture which makes those *striae* to which they have given different imaginary uses, according to their different positions.

Now the vessels of the brain are nerves, veins, and arteries. The nerves are ten pair. The first pair are the olfactory nerves; they rise from the basis of the *corpora striata*, and pass through the holes of the *os cribriforme*. The second pair are the optick nerves; they rise partly from the extremities of the *corpora striata*, and partly from the *thalami nervorum opticom*, which they almost embrace: they unite together above the *cella turcica*, and, immediately dividing again, they pass through the two foremost holes in the *os sphenoides*. The third pair are the movers of the eyes; they rise on each side of the *infundibulum* from the *medulla oblongata*, and go out at the *foramina lacera*. The fourth pair are the pathetick nerves; they rise from the small medullary cord which is behind the *testes*, and pass through the *foramina lacera*. The fifth pair rise from the fore part of the *processus annularis*; they give nerves to the *dura mater*; each of them divides into three branches, the first passes out of the *foramen lacerum*, the second at the third hole of the *os sphenoides*, and the third through another hole of the same bone. The sixth pair rises from the sides of the *processus annularis*, and goes out at the *foramen lacerum*; but, just before it goes out, it casts back a branch, which

which makes the root of the intercostal nerve; this goes out at the canal through which the carotidal artery enters. The seventh is the auditory nerve; it rises from the hind part of the *processus annularis*, and enters the hole in the process of the *os petrosum*. The eighth pair is the *par vagum*; it rises from the *medulla oblongata* behind the *processus annularis*, by several threads which join in one, and it goes out at the same hole the lateral *sinuses* open into the *jugulares*. The ninth pair rises from the *processus olivares* of the *medulla oblongata*, and passes out at a hole in the occipital bone, which is proper to itself. The tenth and last pair rises by several fibres from the beginning of the *medulla spinalis*; from thence ascending within the *occiput*, it turns and passes out at the same hole through which the vertebral artery enters, between the first *vertebræ* and the occipital bone, running through a *sinus* in this *vertebra*. These are the nerves of the brain, which we shall trace farther in the eighth chapter.

The arteries are the two internal carotids which pass through two oblique canals in the *ossa petrosa*: as soon as they enter the skull, they give a branch which enters the orbit of the eye; they give branches which make the *rete mirabile*, then they pierce the *dura mater* on each side of the *infundibulum*; they communicate with the cervical artery, and they give branches to the *plexus choroides*, and are distributed through all the substance of the brain: their branches make many turnings and windings

Of the vessels of the brain.

upon the *pia mater*, and at last are lost in the little glands of the cortical substance of the brain.

The two vertebral arteries, which come out of the holes in the transverse processes of the *vertebræ*, enter the large hole of the occipital bone; they pierce the *dura mater*, and go along the under side of the *medulla oblongata*; then they cast back two branches for the spinal arteries, and at the *processus annularis* they join in one branch called the *cervical artery*. This communicates with the two *carotides*, by two branches called the *communicant branches*; then it divides again into two, which give branches to the *rete mirabile*, *plexus choroides*; and they are afterwards distributed through all the substance of the brain, ending in the cineritious substance, as the *carotidales*.

The veins enter not the *cranium* at the same holes that the arteries do, because, as Dr. Ridley rightly observes, upon any fermentation of the blood, the swelling and pulse of the arteries would compress the veins against the bony sides of their passage, and so cause a stagnation and extravasation of the blood in the brain, which would be the destruction of the whole machine. Neither do the veins run along by the sides of the arteries in the brain, as they do through all the rest of the body; but they rise from the extremities of the arteries, in the cineritious substance of the brain, and go straight to discharge themselves into the *sinuses* of the *dura mater*.

The use of
the brain.

The blood which is brought into the brain
by

by the carotidal and vertebral arteries, is separated by the glands which make the cineritious and cortical substance of the brain, from its finest and most subtil parts, called animal spirits, which are received from the glands by the fibres of the medullary substance, which is the beginning of the nerves. Each nerve therefore is a bundle of very fine and small tubes, of which some are no bigger than the hundredth part of an hair; and these tubes are the excretory ducts of the cineritious, or glandulous part of the brain. This does not only appear from the structure of the brain, but by reason likewise we are assured, that there is such a fluid as we call animal spirits running in the nerves. For seeing all sensation is performed by the nerves, it must be done either by the substance of the nerve, or the fluid which is contained in the nerve: if by the substance of the nerve, it must be by a vibration from the part upon which the impression is made to the brain. Now that there can be no vibration from the impression of external objects upon animal nerves, which are slack, and surrounded all along by other bodies, is evident; and therefore sensation must be performed by the fluid in the nerves.

The motion of this fluid is not swift and rapid as is generally supposed, but slow and languid seeing all its motion proceeds from the dilatation of the arteries compressing the soft substance of the nerves, and from the force by which it is thrust through the glands of the brain. And when the nerves are full of this fine fluid, the impressions of

objects may be communicated to the brain without any quick motion in the animal spirits, either by retarding or stopping their progressive motion, or by causing undulation. If to these we add, that the animal spirits must be confined within their own proper channels, as well as the other fluids of the body, we shall easily perceive how precarious the many ingenious hypotheses are, which the learned Willis has elegantly described in his *System of the nerves and nervous distempers*.

S E C T. IV

Of the Eyes.

THE organs of sight are divided into two parts: the internal part, which is the globe or body of the eye; and the external part, which is those parts about the globe subservient to it.

Of the eye-brows.

The first of these last are the eye-brows, which are nothing but some hairs bunching out above the eye, by some fat which is under the skin in this place. They break the rays of light, that they be not directly darted into the eyes, which would greatly offend the sight, as they do when we look directly upon the sun.

The eye-lids.

The next are the eye-lids, two to each eye. The upper lid moves very quickly, the under very undiscernably.

Its muscles.

The upper eye-lid is lifted up by the *musculus rectus*, which rises from the bottom of the

the orbit of the eye, where the optick nerves pierce the *cranium*; and, passing above the *musculus superbus*, it is inserted by a large tendon to the border of the eye-lids.

Both lids are brought together to shut upon the eye by another muscle, called *orbicularis*. It rises from the great angle of the eye, and its fibres are spread two fingers breadth, covering the under lid: they reach to the little *canthus*, from which continuing its circular fibres which cover the upper lid, it is inserted into the same place from which it arose. Some authors divide this muscle into two, the superior and inferior, which they make to rise from the great *canthus*, and to be inserted into the little *canthus*.

The eye-lids are covered within with a smooth membrane, called *conjunctiva*; Of the conjunctiva. because it is continued upon the fore part of the globe, constituting that which we call the white of the eye; it joins the globe to the edges of the orbit.

The edges of the eye-lids have two small Of the cilia. and soft cartilages, like the segments of a circle, called *cilia*: they keep the eye-lids extended, that every part may be equally raised. Upon them there is a rank of small glands, whose excretory channels open upon the edges of the lids. They yield a wax which fasteneth the eye-lids together whilst we sleep. They are covered with the skin externally, and with the *conjunctiva* internally. Upon the edges of the lids there are also some hairs in form of a palisado, to preserve the eyes, as the eye-brows do, and to

to hinder any filth or flies from falling into the eyes.

Of the glandula lachrymalis.

On the back side of the *conjunctiva*, upon the upper part of the globe, is the *glandula lachrymalis*, pretty large, divided into several lobes, each of which sends out an excretory channel which opens into the fore side of this membrane, where it covers the upper lid. This gland separates the matter of the tears, which, by the continual motion of this lid, moisten the *cornea*, which otherwise would dry and wrinkle by the continual action of the external air.

The edges of the eye lids being of an equal convexity with the ball of the eye, which they touch, as the tears fall from off the *cornea*, they are stopt by the edge of the under eye lid, along which they run till they fall into two small holes in the great *canthus* of the eye, one in each eye lid.

Puncta lachrymalis.

These holes are called *puncta lachrymalia*. They lead to a small membranous bag, which is situated in this corner, upon the *os lachrymale*; from the bottom of which there goes a small pipe, which pierces this bone into the nose, and opens under the upper *lamina* of the *os spongiosum*. It moistens the inner membrane of the nostrils, by the humour of the lachrymal gland, which runs from off the globe into them. Sometimes the acrimony of this humour causeth sneezing, which we hinder by pressing the angle of the eye, and so stop its running.

Between these two *puncta* there is a caruncle, which serves to keep them open when

when the eyes are shut: this caruncle was thought to be the *glandula lachrymalis*.

The globe of the eye is moved by four strait muscles, and two oblique; and betwixt them there is a great deal of fat, which facilitates the motion of the globe.

The first of the four strait muscles is called *attolens*, or *superbus*; it lies upon the upper part of the globe; it pulleth up the eye when we look up. The second is called *deprimens*, or *humilis*; it pulleth down the eye. The third is called *adductor*; it draweth the eye towards the nose. The fourth *abductor*; it draweth the eye toward the little *canthus*. They rise all four from the circumference of the hole in the orbit, thro' which the optick nerves pass; and they terminate about the *cornea* by four thin and broad tendons. When they all act together, they draw the eye towards the bottom of the orbit. When the *superbus* and the *adductor*, or the *abductor*, act together, or the *humilis* and the *adductor*, or *abductor*, act together, they perform the oblique motions, which have been attributed to the oblique muscles.

The first of the oblique muscles, which is the fifth of the eye, is the *obliquus minor*; it rises from the lower side of the orbit, near its external circumference, where the first and second bones of the upper jaw join together, and ascending obliquely by the outer corner of the eye, it is inserted to the upper and external side of the globe behind the tendon of the *abductor*.

The second of the oblique muscles, and the

Of the muscles of the eyes.

the sixth of the eye, is the *obliquus major*; it rises from the bottom of the orbit; and marching obliquely towards the great *canthus*, in the upper part of which, near the brink, there is a cartilaginous ring, through which it passes its round tendon; from whence reverting backwards, it is inserted into the upper part of the globe, behind the tendon of the *attolens*.

The use of the first of these muscles is to draw the globe of the eye forwards, and to turn its pupil upwards; and of the second, to draw it forwards, and to turn its pupil downwards, for the better receiving of the rays of light, which could not be performed by any of the other four muscles (as Mr. Cowper has very well observed). And both of them are an axis for suspending the globe, by which, in its almost continual motion, it is moved the more easily, as has been ingeniously observed by Mons. de la Hire.

Now the globe of the eye is of a spherical figure; in it are contained the principal instruments of vision; it is composed of coats and humours.

Of the conjunctiva.

The first coat is the *conjunctiva*; it makes the white of the eye; it hath been already described: it is full of small veins and arteries, which appear big in an *ophthalmia* or inflammation of the eyes.

Sclerotica.

The second is called *sclerotica*; it is thick, hard, and smooth, opake behind, but transparent before, where it makes the

Cornea.

Third coat, called *cornea*, because it is transparent, like the horn of a lantern, in the fore part of the eye, which is surrounded

ed by the white of the eye: it has a greater convexity than the rest of the globe of the eye, and is composed of several parallel *laminæ*, which are nourished by many blood-vessels, so fine, as not to hinder even the smallest rays of light from entering the eye; and it has a most exquisite sense, that, upon the least pain the tears might be squeezed out of the lachrymal gland, to wash of any filth, which, by sticking to the *cornea*, might render it opake.

The fourth is the *choroides*; it lies under *Choroides*, the *sclerotica*; it is much thinner than it: it hath a great number of blood-vessels which come from the second, and which are spread upon it; as also several glands, which separate from the blood-vessels a black liquor which tinctures all this membrane internally, which is otherwise of a whitish colour. This coat is open, or has a hole before, for the passage of the rays of light, called *pupilla*. That part of this coat which makes the circumference of this hole, and which lies upon the sides of the crystalline humour, is

The fifth coat called *uvea*, which is made *Uvea*, of circular and straight fibres; it contracts and dilates, according to the different impressions of light and of objects.

The *iris* is the outside of the *uvea*, where *Iris*, the different colours appear. On the inside of the *uvea*, from its circumference, which joins the *choroides*, rises the *ligamentum ciliare*. It is made of short fibres, which run upon the fore part of the glassy humour to the edges of the chrystalline, like lines drawn

drawn from the circumference to the centre. By the contraction of these fibres the fore part of the eye is made more prominent, and the *retina* pressed farther back from the crystalline humour, or the *axis* of vision is lengthened when objects are placed too near the eye.

Retina.

The sixth is the *retina*, so called, because it resembles a net, which covereth the bottom of the cavity of the eye: it is a fine expansion of the medullary fibres of the optic nerve upon the surface of the glassy humour, as far as the *ligamenta ciliaria*. It is on this coat that the impression of objects are made.

Of the aqueous humour.

The humours of the eye are three: the first is called the *aqueous*; it lies in the fore part of the globe, immediately under the *cornea*; this humour is thin and liquid, of a spiritous nature, for it will not freeze in the greatest frost. This evinces the necessity of a continual supply for this humour, which, in effect, it hath. For if the *cornea* be pricked, and this humour squeezed out, it shall be restored again in the space of ten or twelve hours.

Crystalline humour.

The second humour is the crystalline; it lies immediately next to the *aqueous*, behind the *uvea*, opposite to the *pupilla*, nearer to the fore part than the back part of the globe; it is the least of the humours, but much more solid than any of them: its figure, which is convex on both sides, resembles two unequal segments of spheres, of which the most convex is its back side, which makes a small cavity in

the glassy humour in which it lies : it is covered with a fine coat, called *aranea*.

The third is the glassy humour ; it hath a great resemblance to the white of an egg ; it filleth all the hind part of the cavity of the globe. It is in a greater abundance than the other two. It is thicker than the aqueous, but thinner than the crystalline humour. It is contained in a very fine coat of the same name. It gives the spherical figure to the eye. Upon its back part the *retina* is spread, which it holdeth from the crystalline humour at a distance requisite to receive the impressi^{on} of objects distinctly.

The optick nerves pierce the globe of the eye a little on the inside of the optick *axes*. Their external coat, which is a production of the *dura mater*, is continued to the *sclerotis*, as their internal from the *pia mater* is to the *choroides* ; and their medullary fibres passing through all, are expanded into the *retina*, upon which the images of objects are painted. The center of this expansion is insensible, and all rays which fall upon it are lost ; and consequently, that point of the objects from which these rays come, is invisible to the eye, as is evident from that famed experiment of Monsieur Mariot. The reason of this insensibility proceeds probably from the blood vessels which enter with the optick nerve, and cover this part of the *retina*. But, whatsoever its cause is, we are extremely obliged to the Maker of our eyes, that the optick nerves are inserted on the inside of the optick

tick *axes* : for if they had pierced the globe of the eye in the optick *axes*, then the middle point of every object had been invisible ; and where all things conduce to make us see best, there we had not seen at all. We must likewise have lost some part of an object, if the optick nerves had been placed on the outside of the optick *axes* : Because an object may be so placed, as that all the rays which come from one point may fall upon the outside of both eyes ; but it is impossible that they should fall upon the inside of both eyes, and therefore that point which is lost in one eye, is visible by the other.

Of the vessels of the eyes.

The vessels of the eyes are branches of the external carotides and jugulars, which are distributed upon the external parts of the eyes, and a vein which opens into the superior *sinus* of the *dura mater*, in the basis of the skull, and an artery from the internal *carotid*. They accompany the optick nerves, and are distributed on the muscles and globe of the eye.

There are also some lymphatics which accompany the blood-vessels. The nerves of the eyes are

Of their nerves.

The optick nerves ; they are pretty big and round. The third pair of the brain, called *motorii* ; the fourth pair, called *pathetici* : the first branch of the fifth pair, called *ophthalmicus* ; and the sixth pair, are all bestowed on the muscles of the eyes.

Of vision.

All the rays which come from one point of an object, are, by the *cornea* and humours of the eye united in a point of the *retina*,

retina, which is in a straight line, drawn from the same point of the object, through the centre of the eye; and consequently all the rays which come from all the points of an object, are united on the *retina*, in the same order and proportion as the points of the object are from whence these rays come. Therefore the impression which these rays make upon the *retina*, must be the image of the object.

Thus in general vision is performed. But now let us see what several parts of the globe conduce in this action. We have said, the *cornea* was more convex than any other part of the globe; by which means, all the rays are gathered to pass through the *pupilla*, and none of them are lost upon the *uvea*.

The aqueous humour being the thinnest and most liquid, easily changes its figure, when either the *ligamentum ciliare* contracts, or both the oblique muscles squeeze the middle of the bulb of the eye, to render it oblong when objects are near to us. How the parts of the eye contribute to it.

The strait fibres of the *uvea* dilate the *pupilla*, when there are but few rays of light; and the circular fibres contract it, when there are too many. When the *pupilla* is contracted, we see most distinctly; when it is dilated, we see most clearly. The glassy humour keeps the crystalline humour at such a distance from the *retina*, as is necessary for uniting the rays which come from one point of the object, exactly in one point of the *retina*.

The impression of the object is made upon the *retina*. The *choroides* is tinctured

black, that the rays of the light which pass through the *retina*, may not be reflected back again, to confuse the image of the object.

Being distinct vision consists in the union of all the rays which come from one point of an object, exactly in one point of the *retina*; and that the rays which come from objects at different distances, are united at different distances, behind the crystalline humour; they cannot both be united exactly upon the *retina*; therefore the eye cannot see equally distinctly at the same time objects at different distances. It is for this reason that the globe of the eye moves so quickly, and almost continually, and that the muscles of the eyes have such a great quantity of nerves to perform their motion.

When the globe of the eye is flat, as happens sometimes in old age, that the rays pass the *retina* before they unite, in such a case there is no distinct vision; and such as have this defect, are called *presbyta*: and if, on the contrary, the globe of the eye be so convex as to unite the rays before they come to the *retina*, neither is there any distinct vision; such as have this defect are called *myopes*.

S E C T. V.

Of the Ear.

Of the external ear.

THE ear is divided into the external and internal. The external ear (whose parts

parts have already been described) is composed of the skin, a cartilage, and a little fat. The skin of this part is thin and smooth; its glands seem to differ from the miliary glands of the skin, in that both in young and old they frequently flow with an unctuous humour, which dries to a sort of scurf in the *concha*. These glands are called by Valsalva, *glandulae sebaceae*. The skin sticks close to the cartilage by means of the *membrana adiposa*, whose cells contain no fat but in the lobe of the ear, where the cartilage does not reach. The vessels of the external ear are arteries from the *carotid* veins, which go to the *jugulares*, and nerves from the *portio dura*, and second pair of the neck.

The external ear is tied to the *os petrosum* by a strong ligament, which comes from the backside of the *pinna*. Though the ear has but a very obscure motion, yet it has two muscles: the first arises from the outside of the frontal muscle, where it joins the *crotophie*, and is inserted into the upper and back part of the *pinna*. The second arises from the upper and foremost part of the *processus mamillaris*, and is inserted into the middle and back part of the *concha*. The first should draw the ear upwards, and the second downwards and backwards; but the continual binding of our ears, when young, deprives us of their use.

The use of the external ear is like a tunnel to gather the sounds, which by its ridges and hollows are directed to the *meatus auditorius*, the first part of the internal ear. Of the meatus auditorius.

ear. This is a conduit which goes from the middle of the *concha* to the *tympanum*: it is near an inch long, about three or four lines, or tenth part of an inch wide; and its passage is not straight, but crooked, passing first upwards, then downwards; then it has a small tendency upwards again, and the lower part of its extremity bends a little down to the obliquity of the *membrana tympani*. The beginning of this passage is cartilaginous, being a continuation of the *concha* contracted; the end of it is bony, being in the temporal bone, which makes the greatest part of the upper and back part of the *meatus*, as the cartilage does of the lower and fore part. The whole cavity within is lined with a membrane, which seems to be a continuation of the skin which covers the *auricula*, and which grows thinner and thinner as it approaches the *tympanum*. On the back side of this membrane, there is a great number of little glands, whose excretory ducts bring into the *meatus* a yellow excrement, whose bitterness and viscosity hinder insects from approaching the *membrana tympani*, which it likewise preserves against the injuries of the air. The cartilage is always slit, and frequently in more than in one place. The *meatus* has the same vessels which the external ear hath, and both have a vein which passes through the eleventh of the external holes of the *cranium*, and discharges itself into the lateral *sinuses*.

Of the
membrane
of the
tympanum.

The inner extremity of the *meatus* is closed with a thin transparent membrane, of an

an oval figure stretched out like the head of a drum, making an obtuse angle with the upper and back part of the *meatus*, and an acute with the lower and fore part. This is the *membrana tympani*, which is set in a bony circle of the temporal bone, and which wants about half a line of being a compleat circle. Valsalva says, that this membrane is double, being composed of the membranes which line the cavities of the *meatus* and the *tympanum*. The handle of a small bone, called the *malleolus*, is tied to this membrane, which it draws somewhat inwards, making a little concave towards the *meatus auditorius*: and there runs a small twig of a nerve from the fifth pair upon its inside, called *chorda tympani*. The upper edge of this membrane, being sometimes not quite closed to the bone, gives a passage for the air from the mouth to the external ear.

Behind this membrane there is a pretty large cavity called the *tympanum*; it is about three or four lines deep, as much wide, and between two and three high. It is lined with a fine membrane, on which there are several veins and arteries. It is always full of a purulent matter in children. In this cavity there are four small bones, of which

The first is the *malleolus* or hammer, so called, because of its shape. Its head has on its lower side two protuberances and a cavity whereby it is joined to the *incus* by Ginglymus: its handle, which is pretty long and small, is fastened to the *membrana tympani*: its whole length is about three lines, or a little

the more. Near its head it has two small processes, and it is moved by three muscles. Its muscles. The first is called the *externus*; it arises from the upper and external side of the *meatus auditorius*, and is inserted into the upper and lower process of the *malleolus*, which it draws outwards. This is necessary when sounds are too great, which might break the *membrana tympani*.

The second is the *obliquus*; it lies in the external part of the conduit which goes to the palate, and, entering the barrel, is contained in a sinuosity of the bone by the upper edge of the *membrana tympani*, and is inserted into the slender process of the hammer, assisting the former muscle in its action.

The third is the *internus*, which arises from the extremity of the bony part of the conduit which leads to the *fauces*, and lies in a *sinus* of the *os petrosum*, till it passes over a little rising of the bone at the *fenestra ovalis*, to be inserted into the posterior part of the handle of the *malleolus*. This muscle, by pulling the hammer inwards, distends the *membrana tympani*.

Of the incus.

The second small bone is called *incus*, the anvil: it has a head and two legs. Its head, which is near two lines long, above one broad, and but half a line thick, has a protuberance and two cavities, whereby it is articulated with the hammer; the shorter of its legs is tied to the side of that conduit, which goes to the *processus mammillaris*, and its longer leg to the head of the third bone, called

The

Dr. John S.

The *stapes* or *stirrup*, because of its resemblance. It is of a triangular figure, being made of two branches set upon a flat basis, which stands upon the *foramen ovale*. The space between the two branches is filled up by a fine transparent membrane; the union of the two branches is called the head of the stirrup, in which there is a small cavity, in which lies the fourth bone. The height of the *stapes* is a line and a half, the length of it is above a line, and the breadth half a line. There is a small muscle, which arises out of a small canal in the bottom of the *tympanum*, and which is inserted into the head of the stirrup. Of the *stapes*.

The *os orbiculare*, which is a very small bone, being convex on that side which is received in the cavity of the head of the stirrup, and hollow on the other side, where it receives the long leg of the anvil, which is only joined to the stirrup by means of this fourth bone. Of the *os orbiculare*.

Besides these bones, there are several holes in the *tympanum*. The first is in its fore part nearest the *membrana tympani*. It is the entry to the *sinus* in the mammillary process. The second is the orifice of a conduit which leads to the palate of the mouth. The beginning of this passage is very narrow and bony; the middle is cartilaginous, and its extremity, which opens near the *uvula*, is above four lines wide, membranous, and dilated by some muscular fibres, as Valsalva says; and they open the extremity of this passage, either when we open our mouths to hear more distinctly, or when it is necessary there Of the holes in the *tympanum*.

there be a free communication between the external air, and that in the cavity of the *tympanum*. The third and fourth are in the internal process of the *os petrosum*. The one is called *fenestra ovalis*; the basis of the stirrup stands upon it; it is the entry to the *vestibulum*. The other is called *fenestra rotunda*: it is covered by a fine membrane, inclosed in a rift of this hole: it leads to the *cochlea*.

Of the vestibulum.

The *vestibulum* is a cavity in the *os petrosum*, behind the *fenestra ovalis*; it is above two lines broad, and as much long, and a line and a half high. In it open the semi-circular pipes of the labyrinth, the upper turning of the *cochlea*, and auditory nerve, at five small holes.

Of the labyrinth.

The *labyrinth* is made of three semi-circular pipes above half a line wide, excavated in the *os petrosum*; they open by five orifices into the *vestibulum*. That which is called the superior pipe, which is generally about five or six lines long, joins one of its extremities with one of the extremities of that which is called the inferior pipe (which is about six or seven lines long) and these two extremities open by an orifice, but the middle pipe opens at each end by itself into the *vestibulum*. This is about four or five lines long.

Of the cochlea.

The last cavity of the ear is the *cochlea*; it resembles a snail's shell. Its canal, which winds in a spiral line, is divided into two, the upper and lower, by a thin *lamina spiralis*, of which that part near the *axis* is bony, but extremely brittle, and that next the

the outer shell is membranous, appearing to be only made of the auditory nerve. The upper canal opens into the *tympanum*, and the lower into the *vestibulum*. This is narrower than that, especially towards the *basis* and the *coclea*, where each is about a line wide, and the *basis* itself is about four lines in diameter.

The vessels of the internal ear are arteries and veins, from the internal *carotidale* and *jugulars*. The *nervus auditorius* enters by the hole in the internal process of the *os petrosum*. It consists of two bundles, of which one is hard, the other soft. Five branches of the *portio mollis* enter the *vestibulum*, as has been said, and form a delicate web, which sends slips, which run through the semi-circular canals; and the rest of the *portio mollis* enters the *coclea* at the centre of its *basis*, and turns with the spiral line, of which it probably makes the membranous part. The *portio dura* passes through its proper passage to be distributed among the external parts about the ear.

Of the vessels of the ear.

A sound is nothing but a certain refraction or modulation of the external air, which being gathered by the external ear, passes through the *meatus auditorius*, and beats upon the *membrana tympani*, which moves the four little bones in the *tympanum*. In like manner as it is beat by the external air, these little bones move the internal air, which is in the *tympanum* and *vestibulum*; which internal air makes an impression upon the auditory nerve in the *labyrinth* and *coclea*, accordingly as it is moved by the

Of hearing.

little bones in the *tympanum*: so that, according to the various refractions of the external air, the internal air makes various impressions upon the auditory nerve, the immediate organ of hearing; these different impressions represent different sounds. The curious structure of the *labyrinth* and *cochlea* render the weakest sounds audible; for the whole organ of hearing being included in a small space, had the auditory nerve run in a straight line, the impressions had been made but upon a very small part of it; and the strength of the impression being *ceteris paribus*, always as the number of parts upon which the impression is made, sounds which are now low could not have been heard at all. If the auditory nerve had, like the *retina*, been expanded into a large web which had covered or lined some wide cavity, the impressions of sounds even in this case had been much weaker than they are now: for this large cavity had given room to the sounds to dilate, and all sounds grow weaker as they dilate. Both these inconveniences are prevented by the present structure of the *labyrinth* and *cochlea*, whose canals, by their winding, contain large portions of the auditory nerve, upon every point of which the smallest sound, being at once impressed, becomes audible; and by their narrowness the sounds are hindered from dilating, and the impressions made upon the nerve by the first dilatations, which are always the strongest. The strength of the impression in narrow channels is likewise increased upon the account of the elasticity of
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of the sides of the bony channel; which, receiving the first and strongest impulses of the air, do reverberate them more strongly upon the auditory nerve.

S E C T. VI.

Of the Nose.

THE *nose* may be divided into two parts: the external and internal. The external part is covered with the skin and some muscles, of which afterwards. Its upper part consists of two bones closely joined together on their upper side. Its lower part is made of four cartilages, of which the first two are fixed to the lower ends of the aforesaid bones: they are also joined together on the upper side; they are pretty broad, and, as they approach the tip of the nose, they grow thinner and softer. The other two ly upon the lower ends of the first two, to which they are tied by a membrane; they are called *narium ala*.

The cavity made by these bones and four cartilages, is divided in its middle into two nostrils, by a partition, of which the upper end is bony, the lower end cartilaginous. The fleshy extremity of this cartilage is called *columna*.

The upper end of each side of this cavity divides into two, of which one goes up to the *os spongiosum*, the other goes down into the *fauces*, and opens behind the palate, by which means we breathe through our nostrils.

strils. At the lower end of this cavity there are two small holes, which pierce the bone of the palate, and open in one behind the *dentes incisivi*; they carry the thin rheum of the nostrils into the mouth.

The cavity is covered by a pretty thick and glandulous membrane; its glands separate that matter which we call *mucus* into the nostrils. On the lower end of this membrane there grow several hairs called *vibrissi*; they, with the *mucus*, which the glands separate, stop any filth from ascending too far into the nostrils.

By the internal part of the nose we understand the immediate organ of smelling; it lies in the upper part of the cavity of the nostrils; it is made of the *os cribriforme*, and its productions, the *os spongiosum*, of which each *lamina* is covered with a fine membrane, upon which the fibres of the olfactory nerves which pass through the holes of the *os cribriforme*, and the fibres of the first branch of the fifth pair which come from the orbit, are spread.

In this membrane there are many small glands, which separate an humour which moistens it, and stops the exhalations of odouriferous bodies, which make their impression upon the olfactory nerves which are spread upon it. Hounds and other beasts, which have a more exquisite smell than men, have also many more *laminae* covered with such a membrane.

Of the conduits which open in the nose.

There are several conduits which open between these *laminae*. The first and second are the *ductus lacrymalis*, of which we have spoken

spoken before. The third and fourth come from the *sinus frontales*. The fifth and sixth come from the nut of the second bone of the upper jaw. The seventh and eighth come from the cells of the *os spongiosum*; they pierce the membrane which covers the first or uppermost *lamina*: and the ninth and tenth come from the *sinus* in the *os sphenoides*. All these conduits carry the liquor which is separate in their cavities into the nostrils, for the moistening its membranes, which otherwise would dry too much by the air which we breathe through our nostrils.

The vessels of the nose are arteries from the carotidals which pass with the olfactory nerves; they are distributed in the internal nose: the external, carotidal, and jugular, and the second branch of the fifth pair, give arteries, veins, and nerves, to the external nose. Some give an account why the smell of bodies, which consist of acrimonious parts, draws tears from the eyes; and why the want of taste does ordinarily accompany the want of smelling, by the communication of the branches of the fifth pair of nerves, which are distributed through these three senses.

Of the vessels of the nose.

S E C T. VII.

Of the Mouth and Tongue.

THE parts of the mouth are the lips, the gums, the palate, the *uvula*, and the surrounding glands.

Of the lips and gums.

Of the Mouth and Tongue.

The lips are made up of several muscles, of which afterwards. Their use is to shut the mouth, and to articulate the voice.

The gums are a hard sort of flesh, formed by the union of two membranes, one of which is a production of the *periosteum*, and the other of the internal membrane of the mouth; they are set about the teeth, to keep them firm in their sockets.

Of the palate,

The palate or roof of the mouth is covered with a pretty thick membrane, which is continued to the tonsils; upon it there are a great number of little glands, whose excretory ducts, piercing it like a sieve, discharge a liquor for the moistening and dissolving of the aliments. It is an error to think that the palate tastes; for by it it is impossible to distinguish the most acrid substances.

Of the uvula and its muscles.

The *uvula* is a reduplicate or production of the internal membrane of the mouth; its substance is very lax, and it has a number of small glands as in the palate: it is somewhat long, of a conick figure; it hangs from the roof of the mouth, at the extremity of the passage which comes from the nose above the *larynx*, between the tonsils.

It is moved by two pair of muscles, which are,

The *pterygostaphylinus externus*; it arises fleshy from a small protuberance, upon the under side of the body of the *os sphænoides*, and goes directly to be inserted into the hind part of the *uvula*.

The *pterygostaphylinus internus* arises from the same protuberance of the *os sphænoides*, and

and growing into a small round tendon, which passes over a small process, like a hook, of the *processus pterigoideus*; from thence reverting, it is inserted into the fore part of the *uvula*.

When the first of these muscles acteth, it pulleth the *uvula* backwards; when the second contracteth, it pulleth the *uvula* forwards; because of the pulley through which its tendon passes, which alters the direction of its motion; both which motions are necessary for the articulating the voice, and in deglutition, that nothing may regurgitate into the nose which we take by the mouth. Of the parotides.

The glands, which are the sources of the spittle, which discharges itself into the mouth, are in great number, of which the principal are the *parotides*, one on each side, situated under the ear, above the *musculus masseter*; they are of the conglomerate sort, being made up of a great number of smaller glands, each of which sends out a small excretory duct; and they all unite and form one channel, called *ductus salivaris superior*, which, running over the cheek, pierces the *buccinator*, and open the mouth. When the *masseter* acteth in mastication, it presses the *saliva* into the mouth.

The *maxillares*, which are situated within Of the maxillares. the under jaw, one in each side, are also of the conglomerate sort; the excretory pipes of their small glands unite, and form two ducts, which both together open under the tip of the tongue, on the inside of the *dentes incisivi*, where they have each a small *papilla* at their orifice. When the muscles

of the tongue or lower jaw act, they compress these glands.

Of the sub-linguales.

The *sublinguales* are one on each side of the tongue; they have sometimes two excretory ducts, as the former, formed by the union of that of each small gland; they run on each side of the tongue, near its tip, where they open into the mouth, just by the former, with which sometimes they join: sometimes these are wanting, and then each little gland has a duct which opens under the tongue: when the *mylohyloideus* acteth, it compresseth them.

Of the tonsillæ.

The *tonsillæ*, or almonds, are two round glands placed on the sides of the basis of the tongue, under the common membrane of the *fauces*, with which they are covered; each of them hath a large oval *sinus* which opens in the *fauces*, and in it there are a great number of lesser ones, which discharge themselves through the great *sinus*, of a mucous and slippery matter, into the *fauces*, *larynx*, and *œsophagus*, for the moistening and lubricating these parts. When the muscle *œsophagus* acteth, it compresseth the *tonsillæ*.

Besides these there are a great number of little glands spread upon the cheeks and lips, called *glandulæ buccales* and *labiales*, whose excretory channels open into the mouth, and all of them separate a sort of *saliva*, or spittle, which conduces to the dissolution of the aliments.

The tongue is connected in the mouth to the *os hyoides*, and to the *larynx*, by a membranous ligament which is in the middle

dle of its lower side. Sometimes the ligament is continued to the tip of the tongue, and then it hindereth children from sucking; therefore in such a case it should be cut.

The tongue is covered with two membranes. The external hath upon its upper part, and particularly towards the tip of the tongue, a great number of *papillæ*, of a pyramidal figure; they stand not up straight, but incline towards the basis of the tongue; they appear not so plainly in men as in brutes, in some of which last they grow cartilaginous. Each *papilla* has a small root, which makes a small hole in the viscous substance, which lies between the two membranes. In men, the chief use of these *papillæ pyramidales* seems to be for preserving the *papillæ nervosæ*, which are of a softer substance, that they be not hurt by the hardness, or roughness, of the aliments: and in beasts which feed upon grass, which they gather together with their tongue, these *papillæ* are like so many hooks, for the grasping, cutting, and pulling of the grass; and perhaps by their roughness rubbing upon the palate, they conduce to press the spittle out of the glands. Towards the basis of the tongue are to be seen several small glands like those of the cheeks.

Under the external membrane there lies a thin viscous substance, which is white on that side next the external membrane, and black on that side next the internal. When the tongue is boiled, this substance hardens, and

and is like a searce, being full of small holes made by the roots of the *papillæ pyramidales*.

The internal membrane is thin and soft; upon it there appear several *papillæ* made of the extremities of the nerves of the tongue, therefore they are called *nervosæ*: they are situated upon the sides of the tongue, but chiefly towards its tip; they resemble the small horns of a snail; for the extremities are round, and bigger than the rest of their bodies. The extremity of each *papilla* pierces the external membrane of the tongue. They quit those holes, and remain on the internal membrane, when the external is raised. These *papillæ* are the immediate organ of tasting.

The substance of the tongue is musculous, being made of plans of fibres of different directions.

The first, or external plan, is made of straight fibres, which surround the tongue, reaching from its basis to its point: When they contract, they shorten the tongue. Under them there are several plans of fibres, which run from one edge of the tongue to the other; they draw the edges of the tongue together. There are also several plans of fibres, which run from the under to the upper side of the tongue; when they contract they make the tongue broad and thin. These two sorts of fibres ly *stratum super stratum*, from the tip of the tongue to its basis; first a plan of one sort, and then a plan of the other sort. There is
some

some fat betwixt these fibres, but chiefly towards the basis of the tongue.

The vessels of the tongue are veins from the jugulars, called *ranulares*: it has arteries from the carotidals, and nerves from the fifth and ninth pair.

The muscles of the tongue are three pair. Of its muscles.

The *styloglossus*; it arises fleshy from the *processus styloides*; from thence descending, it is inserted into the root of the tongue. It draws the tongue upwards.

The second pair is the *genioglossus*; it arises from the inside of the fore part of the lower jaw, and is inserted into the root of the tongue; it pulls the tongue out of the mouth.

The third is the *ceratoglossus*; it arises broad and fleshy from the sides of the *os hyoides*, and is inserted into the root of the tongue; it pulls the tongue directly into the mouth. The fibres of this muscle, which are nearest the extremities of the *os hyoides*, were only called the *ceratoglossus*; and those which were nearest the basis of the *os hyoides*, were called the *basioglossus*: But I see no reason to distinguish them, being they ly in the same plan, and their fibres have the same direction, origination, and insertion.

The tongue is not only moved by these muscles, but also by a bone called *os hyoides*. Of the os hyoides. Now this bone lies at the root of the tongue: its figure is like the Greek letter υ ; it is composed ordinarily of three bones. That in the middle makes its basis, it

it is shorter than the other two ; it is convex without, but concave within ; the other two are joined to its two ends by two intervening cartilages ; they are much longer than the first ; they have each a cartilage at their extremities, and they are called the *cornua*, or horns.

The basis of this bone is joined to the root of the tongue ; and its horns are joined to the upper angles of the *cartilago thyroïdes*, and by two small and round ligaments to the *processus styloides* of each side. This bone is moved, and with it the tongue, by five pair of muscles.

Of its muscles,

The first is the *geniohyoidæus* ; it arises fleshy from the fore part of the lower jaw internally, and is inserted into the basis of the *os hyoides*. It pulls the *os hyoides* and the tongue upwards and forwards.

Its antagonist is the *sternohyoidæus* ; it arises from the inside of the *clavicula*, and ascending above the *sternothyroidæus* it is inserted into the basis of the *os hyoidæus*, which it pulls downwards.

The third is the *mylohyoidæus* ; it ariseth fleshy from the inside of the lower jaw, under the *dentes molares*, and is implanted into the sides of the basis of the *os hyoides* : It draweth this bone and tongue obliquely upwards.

Its antagonist is the *coracohyoidæus* ; it is wrong named ; for it arises not from the *processus coracoides*, but from the upper edge of the *scapula* near its neck, and ascending obliquely under the *mastoidæus*, it is inserted into the *os hyoides*, which it pulls obliquely downwards.

downwards. The belly of this muscle is a little tendinous in its middle, that the vessels which go to the head be not compressed when it acteth.

The fifth pair is the *stylohyoidæus*; it rises from the *processus styloides*, and descending obliquely, is inserted into the horns of the *os hyoides*, which it draws to one side, and a little upwards.

The belly of the muscle is perforated for the passage of the tendon in the middle of the *digastricus*.

A LIST of the different Sorts of Glands in the Body.

1. *Cerebri.*
2. *Plexus choroidæi.*
3. *Sebaceæ.*
4. *Meatus auditorii.*
5. *Ciliares.*
6. *Lachrymales.*
7. *Humorem aqueum*
8. *Chrystallinum*
9. *Vitreum*
10. *Atrum choroides*
11. *Nasales.*
12. *Buccales, labiales, palatinæ.*
13. *Parotides, maxillares, sublinguales.*
14. *Tonsillarum.*
15. *Oesophageæ.*
16. *Asperæ arteriæ.*
17. *Pericardii.*
18. *Mammarum.*
19. *Ven.*

} *secernentes.*

Of the Mouth and Tongue.

19. *Ventriculi.*
20. *Intestinorum.*
21. *Pancreatis.*
22. *Hepatis.*
23. *Vesicæ felle.*
24. *Renum.*
25. *Renales.*
26. *Ureterum.*
27. *Vesicæ urinariæ.*
28. *Urethræ.*
29. *Testiculorum.*
30. *Prostatarum.*
31. *Uteri.*
32. *Vaginæ.*
33. *Lymphaticæ.*
34. *Pinguedinales.*
35. *Medullares.*
36. *Artuum.*
37. *Cutis milliares.*

All these glands seem to me to separate different humours from the blood ; but if any one shall contest the existence of some of them, or maintain that several of them separate the same sort of humour, I shall not dispute it.

C H A P. V.

Of the Bones.

S E C T. I.

Of the Bones in general.

THOUGH, after the description of the three cavities, it is usual to give the myology ; yet, because it cannot be understood without a perfect knowledge of the bones, therefore we shall begin with them.

The bones are made up of hard fibres, tied to one another by small tranverse fibres, as those of the muscles are. In a *fœtus* those fibres are porous, soft, and easily discerned. It is probable that they are nourished by the serous or lymphatick part of the blood, which is brought to them by the arteries, and carried back by the veins. As their pores fill with a substance of their own nature, such as we suppose the *lymph*a to be, so they increase, harden, and grow close to one another ; but when their pores are full of this substance, then the bones are grown to their utmost extent, hardness, and solidity ; their blood-vessels, being compressed on all sides by their bony channels, bring no more blood than what is sufficient to supply the places of their decaying particles.

All the bones of the body which have any of the use of the marrow, considerable thickness, have either a large cavity,

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cavity, or they are spongy, and full of little cells : in both the one and the other there is an oleaginous substance called marrow, contained in proper vesicles or membranes, like the fat. In the large bones, this fine oil, by the gentle heat of the body, is exhaled through the pores of its small bladders, and enters some narrow passages, which lead to some fine channels excavated in the substance of the bone, according to its length ; and from these other cross passages (not directly opposite to the former, lest they should weaken the bone too much in one place) carry the marrow still farther into more longitudinal channels placed nearer the surface of the bone. All this contrivance is, that the marrow may supple the fibres of the bones, and render them less apt to break.

All the bones in the body, except the teeth, and where the bones are articulate to one another, are covered with a thin, but strong and close membrane, called *periosteum* : it hath an exquisite sense, which gives me ground to think, that it is an expansion of some of the tendinous fibres of the muscles. Its use is to sustain the vessels which enter the substance of the bones with their nourishment.

Each large bone is much bigger at its extremities than in the middle, that the articulations might be firm, and the bones not easily put out of joint : but because the middle of the bone should be strong, to sustain the weight of the body, and resist blows and falls, therefore the fibres there are closely compacted

compacted together, supporting one another; and the bone is made hollow, and consequently not so easily broken as it must have been, had it been solid and smaller: for of two bones of equal length and equal numbers of fibres, the strength of the one will be to the strength of the other as their diameters.

On the external surface of the bones there are several cavities and protuberances. The cavities are of two sorts, either narrow and shallow, or wide and deep. The first sort is called *glene*; the second *cotyle*. But in describing the bones in particular, we shall also describe their cavities. The protuberances are also of two sorts, viz. *apophysis* and *epiphysis*. The *apophysis* is a protuberance made by the fibres of the bone; an *epiphysis* is a protuberance made by a small bone set upon the extremity of a bigger bone, which, as we advance in age, unite in one. Both the one and the other are ordinarily upon the extremities of the bones; and they are either for the insertions of muscles, whose force they greatly augment, or for the articulation of the bones. All their difference is from their figure. If it be a large and round protuberance, it is called *caput*; and the part immediately under it *cervix*: but if it be small and round, then it is called *condylus*. If it be a sharp protuberance, then it is called *corone*, *styloides*, *coracoides*, &c. according to its figure.

In the bones there are much volatile salt and spirit, which are very subtile and penetrating;

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trating;

Of the cavities and protuberances of the bones.

Analysis of the bones.

trating; some sulphur which is very stinking, a little phlegm, and much earth.

S E C T. II

Of the Cartilages and Ligaments in general.

A Cartilage is a smooth and solid body, softer than a bone, but harder than a ligament. In it there are no cavities nor cells for containing of marrow, nor is it covered with any membrane to make it sensible, as the bones are. The cartilages have all a natural resort, by which, if they are forced from their natural figure or situation, they return to it of themselves, as soon as the force is taken away. They are chiefly in those places where a small and easy motion is required, as in the ears, nose, *larynx*, *trachea*, *arteria*, and *sternum*; and their natural elasticity serves instead of antagonist muscles. They cover also the ends of all the bones, which are joined together for motion. First, because they are smoother than the bones. Secondly, because they are without sense. And, thirdly, being softer than the bones, the attrition which is made by the motion of the joint is the more easily supplied.

A ligament is a white and solid body, softer than a cartilage, but harder than a membrane; they have no conspicuous cavities, neither have they any sense, lest they should always suffer upon the motion of the joint. Their chief use is to fasten the bones, which

which are articulated for their motion, together, lest they should be dislocated in any violent motion.

S E C T. III.

Of the Articulation of the Bones.

THE bones are articulated, or joined to one another, either with a manifest motion, or with a small and obscure motion, or without any motion at all. The first sort of articulation is called *diarthrosis*: the second, because of the cartilage by which it is performed, is called *synchondrosis*: and the last *synarthrosis*. Of the joining of the bones.

Of the *diarthrosis* there are two sorts, viz, *enarthrosis* or *arthrodia*, and *ginglymus*. The first is, when a round head of a bone is received into a round cavity of another, such as the articulation of the *femur* with the *ischium*; and this sort of joining is called, by tradesmen, the ball and socket. The property of this joining is, that the parts so articulated move equally to any side. The *ginglymus* is, when a bone receives and is received; and the property of this sort of articulation is to admit only of the motions of the flexion and extension: it is called by tradesmen *charnall*, and it is commonly used in *hinges*. Of this articulation there are three sorts. The first is, when the end of a bone has two protuberances and one cavity; and the end of the bone, which is articulated with it, has two cavities and one

Of the Articulation of the Bones.

one protuberance, as the *humerus* and the *u'na*. The second is, when a bone at one extremity receives another bone, and at its other extremity it is received by the same bone, as the *radius* and *ulna*. The third sort is, when a bone at one end receives another bone, and at the other end it is received by a third bone, as the *vertebræ* do.

The second sort of articulation, which is called *synchondrosis*, is when the extremities of the two bones are joined to one another by means of an intervening cartilage. Thus the bodies of the *vertebræ*, and the extremities of the ribs and *sternum* are joined together, where, though the motion of all is manifest, yet that of any two is hardly discernible.

The third manner of articulation, called *synarthrosis*, is of two sorts, *viz.* *sutura* and *gomphosis*. The *sutura* is, when two bones are mutually indented in one another; the teeth by which they are indented are of various figures; sometimes they are like the teeth of a saw; sometimes they are broad at their extremities, and narrow at their basis; sometimes the sides of the teeth are likewise indented, and sometimes there are little bones between the teeth, which are also indented; these are most frequently in the *sutura lambdoidalis*, and they serve as wedges to keep the teeth firm. Besides these little bones there is ordinarily a viscous humour which glews the indentations together, and which perfectly unites them in several old persons.

This sort of articulation is called by join-
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ers *Dove-tailing*, and is used in drawers, cabinets, and boxes. All the bones of the *cranium* and upper jaw, as also all the *epiphyses* of the bones, are joined by this sort of articulation.

Gomphysis is when one bone is fastened in another, as a pin or nail is in a piece of wood; and the teeth only are articulated this way in their sockets.

To these we may add a third kind of *synarthrosis*, very different from any of the former, which is, when a bone has a long and narrow channel, which receives a small process, or the edge of another bone; and thus the *vomer* is articulated to the *os sphenoides* and *septum narium*: by tradesmen this manner of joining is called *ploughing*, which we may therefore call *κινδύλῃσις*. These comprehend all the different joinings of bones in the human body; therefore I shall not mention several others which we find in authors to no purpose.

The extremities of all the bones that are articular to one another with a manifest motion, are bound together by membranous ligaments which rise from the conjunction of the *epiphysis* with the bone; and, pressing over the articulation, are inserted at the place in the other bone. Thus they form a bag, which embraces all that part of the extremities of both bones which play upon one another, and in this bag is contained a mucilage for the easier motion of the joint; this mucilage is separated by some glands which ly in some fat on the inside of the ligaments. These bones which are articulated by a
ginglymus

ginglymus have the ligaments much stronger on their sides than they are either before or behind, that the protuberances may be kept to play true in their cavities; for if they might slip the least to either side, the bones would be frequently out of joint.

S E C T. IV.

Of the Bones of the Cranium.

THE *cranium* or skull is made up of several pieces, which, being joined together, form a considerable cavity, which contains the brains, as in a box.

The bigness of the *cranium* is proportionate to the bigness of the brain. Its figure is round, a little depressed on its sides. A round figure being the most capacious, was fittest to contain a great quantity of brains: and the flatness of its sides helps to enlarge the sight and hearing.

Each bone in the *cranium* is made up of two tables or *laminæ*, between which there is a thin and spongy substance, made of some bony fibres, which come from each *lamina*, called in Greek *diploe*, in Latin *medullium*.

In it there are a great number of veins and arteries, which bring blood for the nourishment of the bones. The tables are hard and solid, because in them the fibres of the bones are close to one another. The *diploe* is soft, because the bony fibres are
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at a greater distance from one another. By this contrivance the *cranium* is not only made lighter, but also less subject to be broken.

The external *lamina* is smooth, and covered with the *pericranium*. The internal is likewise smooth; but on it there are several furrows made by the pulse of the arteries of the *dura mater*, whilst the *cranium* was soft and yielding.

The bones of the *cranium* are joined to one another by four sutures. The first is called the *coronalis*. It reaches transversely from one temple to the other; it joins the *os frontis* with the *ossa parietalia*. The second is called *lambdoidalis*, because it resembles the Greek letter (λ) *lambda*; it joins the *os occipitis* to the *ossa parietalia* and *petrosa*. The third is called *sagittalis*; it begins at the top of the *lambdoidalis*, and runs straight to the middle of the *coronalis*; it joins the two *ossa parietalia* together. The fourth is called *sutura squamosa*, because the parts of these bones which are joined by this suture are, as it were, cut slope-ways, and lapped over one another.

This suture joins the semi-circular circumference of the *ossa temporum* to the *sphenoides occipitis*, and to the *parietalia*. The first three sutures were called *suturae verae*; and the last *sutura falsa*, because it was supposed to have no indentations, which is false.

The bones of the *cranium* are not only joined to one another, but they are also joined to the bones of the upper jaw by three other sutures. The first is the *transversalis*; the second is the *ethmoidalis*; and the third is the *sphenoidal*.

it runs across the face; it passes from the little angle of the eye down to the bottom of the orbit, and up again by the great angle of the eye over the root of the nose; and so to the little angle of the other eye. It joins the *os frontis* to the bones of the upper jaw. The second is the *ethmoidales*; it surrounds the bone of that name, and joins it to the bones which are about it. The third is the *os sphænoïdales*; it surrounds the *os sphænoïdes*, joins it to the *os occipitis*, the *ossa petrosa*, and to the *os frontis*.

The *cranium* is made of several pieces joined together by its futures, that it might be the stronger, and less apt to break, that several membranes and vessels which suspend the *dura mater*, and which go to the *pericranium*, may pass through the future, and that the matter of transpiration may pass through them.

Of the bones
of the skull.

Now the bones of the *cranium* are six proper, and two common to it and the upper jaw. The six proper are, the *os frontis*, which makes the fore part of the skull; the *os occipitis*, which makes the hind part; and the *ossa parietalia* and *temporum*, which make the sides. The two common are, the *sphænoïdes* and the *os ethmoïdes*, which are part of the basis of the skull.

Os frontis.

The first of the proper is the *os frontis* or *coronale*; it is almost round; it joins the bones of the *sinciput* and temples, by the coronal future, and the bones of the upper jaw by the *sutura transversalis*, and the *os sphænoïdes* by the *sutura sphænoïdalis*. It forms the upper part of the orbit, and it has
four

four *apophyses* which are at the four angles of the two orbits. It has two holes above the orbits, through which pass a vein, artery, and some twigs of the first branch of the fifth pair of nerves. It has also one in each orbit, a little above the *os planum*, through which a twig of the ophthalmick branch of the fifth pair passes to the nose; it is the *orbiter internus*. It has two *sinuses* above the eye-brows, between its two tables; they are lined with a thin membrane, in which there are several blood-vessels and glands, which separate a mucous serosity, which falls into the nostrils. The inside of this bone has several inequalities, made by the vessels of the *dura mater*. It has two large dimples made by the anterior lobes of the brain. Above the *crista galli* it has a small blind hole, into which the end of the *sinus longitudinalis* is inserted. From this hole it has a pretty large spine which runs up along its middle; instead of this spine, there is sometimes a *sinus*, in which lies the *sinus longitudinalis*, which ought to be observed carefully by surgeons in wounds in this place. This bone is thicker than the *sinciput* bones, but thinner than the *os occipitis*. In children it is always divided in its middle by a true future.

The second and third are the bones of the *Ossa parietalia*. *sinciput* called *parietalia*; they are the thinnest bones of the *cranium*; they are almost square, and somewhat long; they are joined to the *os frontis* by the *sutura coronalis*, to one another in the crown of the head by the *sutura sagittalis*, to the *os occipitis* by the

the *lambdoidalis*, and to the *ossa temporum* by the *sutura squamosa*. They are smooth and equal on their outside, but on their inside they have several furrows made by the pulse of the arteries of the *dura mater*. They have each a small hole near the *sutura sagittalis*, through which there pass some veins which carry the blood from the teguments to the *sinus longitudinalis*.

Ossa temporum.

The fifth and sixth are the *ossa temporum*, situated in the lower part of the sides of the *cranium*; their upper part, which is thin, consisting only of one table, is of a circular figure, and is joined to the *ossa parietalia* by the *sutura squamosa*: their lower part, which is thick, hard, and unequal, is joined to the *os occipitis*, and to the *os sphenoides*; this part is called *os petrosum*. They have each three external *apophyses* or processes, and one internal. The first of the external is the *processus zygomaticus*, which runs forwards and unites with the process of the *os mali*, making that bridge called the *zygoma*, under which lies the tendon of the *crota-phite* muscle. The second is the *mamillaris*, or *mastoidæus*; it is short and thick, situated behind the *meatus auditorius*. The third is the *processus styloformis*, which is long and small; to it the horns of the *os hyoides* are tied. The internal process is pretty long and big in the basis of the skull; it contains all the cavities and little bones of the ear, which have been already described. The holes in the temporal bones are two internal, and four external. The first of the internal is the hole through which the audito-

ry nerve passes; the second is common to it and the *os occipitis*: the eight pair of nerves, and the lateral *sinuses* pass through it. The first of the external holes is the *meatus auditorius externus*. The second opens behind the palate; it is the end of that passage which comes from the barrel of the ear to the mouth. The third is the orifice of the conduit by which the carotidal arteries enter the *cranium*: and the fourth is behind the *processus mastoideus*; by it passes a vein which carries the blood from the external teguments to the lateral *sinuses*. Sometimes this hole is wanting; there is another which is between the *processus mastoideus* and the *styliformis*, through which the *portio dura* of the auditory nerve passes. They have each a *sinus* lined with a cartilage under the *meatus auditorius*, which receives the condyle of the lower jaw.

The sixth bone of the *cranium* is the *os occipitis*; it lies in the hinder part of the head; it is almost like a lozenge with its lower angle turned inwards; it joins the *ossa parietalia* and *petrosa* by the *sutura lambdoidalis*, and the *os sphænoides* by the *sphænoidalis*. It is thicker than any of the other bones of the *cranium*, yet it is very thin where the *splenius*, *complexus*, and *trapezus* are inserted. Externally it is rough, internally it has two *sinuses*, in which lie the two protuberances of the *crebellum*, and two large furrows in which lies the *sinus lateralis*. It has seven holes; the first two are common to it, and the *ossa petrosa*; the lateral *sinuses* and the *par vagum* pass
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through them. The third is the great hole through which the *medulla spinalis* passes. The fourth and fifth are the holes through which the ninth pair of nerves pass. The sixth and seventh are two holes, through which there pass two *veins* which bring the blood from the external *teguments* to the *sinus lateralis*; sometimes there is but one, and sometimes none of these two; there are sometimes two more, through which the vertebral veins pass. This bone has also two *apophyses*, one on each side of the great hole; they are lined with a cartilage, and articulated with the first *vertebra* of the neck. It has also a protuberance in its middle, from which there goes a small ligament, which is inserted into the first *vertebra* of the neck. It is longer in beasts than in men.

Os sphæno-
ides.

The first of the bones common to the skull and upper jaw is the *sphænoides*. It is a bone of a very irregular figure. It is situated in the middle of the basis of the skull. It is joined to all the bones of the *cranium* by the *sutura sphænoïdalis*, except in the middle of its sides, where it is continued to the *ossa petrosa* as they were one bone. On its outside it has five *apophyses*. The first two are broad and thin like a bat's wings, they are called *pterigoides*; they have each a pretty long *sinus*, from which the muscle called *pterigoidæi* arises; and at their lower end they have each a small hook like a process, upon which the *peristaphylinus externus* turns its tendon. The third and fourth make the internal and lower part of the orbit; and the fifth is a little *apophyse* like the *crista*

crista galli in its fore part, which is received in a cavity at the further end of the *vomer*. There is also a little small protuberance in the middle of this bone, from which the muscles of the *uvula* arise. On its inside it has four processes called *clinoides*; they form a cavity in the middle of this bone called *cella turcica*; in which lies the *glandula pituitaria*. Betwixt the two tables of this bone, under the *cella turcica*, there is a *sinus*, divided in two in its middle, which opens by two holes into the cavity of the nostrils. In the *os sphænoïdes* there are twelve holes. By the first and second pass the optick nerves; by the third and fourth, which are called *foramina lacera*, pass the third pair, fourth pair, first branch of the fifth pair, and the sixth pair; by the fifth and sixth pass the second branch of the fifth pair; by the seventh and eighth pass the third branch of the same pair; the ninth and tenth enter the arteries of the *dura mater*; and by the eleventh and twelfth enter the internal carotidals, and the intercostal nerve goes out. The canals by which the carotidals enter are oblique; the beginning of them is made in the *ossa petrosa*, and they open within the skull in the *sphænoïdes*.

The second and last of the common bones *Os ethmoides* is the *os ethmoides*, situated in the middle of the basis of the *os frontis*, joined to that bone and to the *os sphænoïdes* by the *sutura ethmoidalis*. In its middle it has a small process called *crista galli*, to which the fore end of the *falx* is tied. This bone is perforated by a number of small holes through

which the fibres of the olfactory nerves pass, therefore it is also called *os cribriforme*. From its under side there goes a thin bone, which divides the cavity of the nostrils in two; the lower edge of this bone is grooved with the *vomer*. On each side of this partition it has several thin spongy *laminae*, called *ossa spongiosa*; they are full of little cells, where they are joined to the *ethmoides*. There are two *laminae*, which neither adhere to the *os ethmoides*, nor to the other *laminae*, but only by the membrane which covers them all. The two external *laminae* of the *ossa spongiosa*, make part of the orbit at the great *canthus*; and they are called *ossa plana*, because they are smooth and even.

S E C T. V.

Of the Bones of the upper Jaw.

THE bones of the upper jaw are two, common to it and the skull, which have been already described; and eleven proper, that is, five in each side, and one in the middle: they are joined to the bones of the skull by the three common sutures, and joined to one another by a fine but true suture.

Os mali.

The first of the proper bones is the *os mali* or *zygoma*; it is of a triangular figure. Its upper side makes the lower and external part of the circumference of the orbit, where it joins the *os sphenoides*. Its internal

nal side joins the *os maxillare*. Its external has a long process, which, joining that of the *ossa temporum*, forms the *processus zygomaticus*; it joins the *os frontis* at the little angle of the eye. It is concave within, and it sticks out a little forwards, making the highest part of the cheek.

The second is the *os maximum*, or *maxillare*, because in it all the teeth of the upper jaw are set. It is of a very irregular figure. On its outside it joins the *os mali*. Its upper side makes the lower and internal part or circumference of the orbit. At its great *canthus* it joins the *os unguis* and *frontis*. The lower side of the *os nasi* is joined to it. Under the upper lip it joins with its fellow of the other side, and both joined together make the fore and greatest part of the roof of the mouth. It is very thin, and between its two *laminæ* it has a large cavity which opens by a small hole into the nostrils. In its lower end it has sixteen *sinuses* or sockets, in which the teeth are set. It has a small hole called *orbiter externus*, in that part of it which makes part of the orbit, through which the nerves of the fifth pair, which come from the teeth, pass. Behind the *dentes incisivi*, where it joins with its fellow, it has another which comes from the nostrils.

The third is the *os unguis*; it is a little thin bone which lies in the great angle of the orbit; it has a hole in which the lachrymal sack lies. I see no reason why this bone should be counted a bone of the upper jaw, seeing it lies entirely in the great an-

Of the Bones of the upper Jaw.

gle of the orbit; there is more reason to count it a *lamina* of the *os spongiosum*, than the *os planum*.

The fourth is the *os nasi*; this is a thin but solid bone, which makes the upper part of the nose: its upper end is joined to the *os frontis* by the *sutura transversalis*: one of its sides joins its fellow, where they are supported by the *septum narium*. Its other side joins the *os maxillare*. Upon its lower end the cartilages of the nostrils are fastened. Externally it is smooth, but internally it is rough.

Os palati.

The fifth bone of the upper jaw is the *os palati*; it is a small bone almost square; it makes the posterior part of the roof of the mouth. It is joined to that part of the *os maxillare* which makes the fore part of the palate. It is also joined to its fellow, and to the *processus pterigoidæus*. It has a small hole through which a branch of the fifth pair of nerves goes to the membrane of the palate.

The eleventh and last is called the *vomer*; it is situated in the middle of the lower part of the nose. It has a cleft in its upper side, in which cleft it receives the lower edge of the *septum nasi*. In its further end it receives a small *apophyse* of the *os sphænoides*, and its under side joins the *os palati*.

By what has been said, you see, that the bones of the skull and upper jaw compose the orbit of the eye. The upper part of it is made of the *os frontis*; the *os unguis* and *os planum* make the inner and lower part of the great angle; and the *os sphænoides*

noides the inner and lower of the little angle. The *os maxillare* makes the inner and lower part of the circumference, and the *os mali* the outer and lower part.

Let us now briefly recapitulate all the holes in the head. They are either external or internal. The external holes are, 1. The two in the coronal bone above the orbit, through which a vein, artery, and a nerve from the ophthalmick branch of the fifth pair pass, for the brow and frontal muscle; this frequently appears only as a notch. 2. The *orbiter internus* in the same bone within the orbit, a little above the *os planum*, for another branch of the fifth pair of nerves which go to the nose. 3. Is between the *os unguis* and the *os maxillare*, in the great *canthus*, through which the *ductus lachrymalis* passes to the nose. 4. *Orbiter externus* in the *os maxillare* below the orbit through which the nerves and vessels which come from the teeth pass to the cheek. 5. One single hole in the same bone, behind the fore teeth, which comes from the nose. 6. Two in the *ossa palati*, through which a branch of the fifth pair of nerves passes to the palate, *uvula*, and gums. 7. In the temporal bone between the *processus mastoideus* and *styloformis*, through which the *portio dura* of the auditory nerve passes. 8. The *ductus auditorius externus*. 9. The *ductus auditorius internus*. 10. The conduit for the carotidal artery. 11. In the same bone through which a vein passes from the external teguments to the lateral *sinuses*; this is behind the *processus mastoideus*. 12. In the

the occipital bone behind its *apophyse*, through which the vertebral veins pass. 13. In the same bone for a branch of the external jugular. 14. One single large hole for the *medulla spinalis*.

The internal holes are, 1. The blind holes above the *crista galli*. 2. The holes in the *os ethmoides*. 3. In the *os sphænoides* for the optick nerves. 4. The *foramen lacerum*, through which the third, fourth, first branch of the fifth, and sixth pair of nerves pass. 5. For the second branch of the fifth pair of nerves. 6. For the third branch of the same nerve. 7. The *foramen arteriæ duræ matris*. 8. The canal through which the carotid enters, and the intercostal passes out; but this we counted among the external holes. 9. In the *process* of the *os temporum*, through which the auditory nerve passes. 10. Between the temporal and occipital bones, it is divided in two by the *dura mater*; through the one part passes the eighth pair of nerves, and the *nervus accessorius*; through the other the lateral *sinuses* open into the internal jugulars. 11. One in each side of the large hole of the *occiput*, through which the ninth pair of nerves go out.

S E C T. VI.

Of the lower Jaw.

THE lower jaw is made of one bone whose fibres at the chin, in children, do not ossify till they are about two years old.

old. It is composed of two tables, which are pretty hard and smooth; but betwixt these two *laminæ* it is porous, and full of little cavities: its figure resembles the letter *v*; at each extremity it has two processes; the uppermost is called *corona*; it is thin and broad at its beginning, but it ends in a sharp point, which passing under the *processus zygomaticus*, has the tendon of the *crota-phite* muscle inserted into it. The other, which is shorter and lower, has a round head, lined with a cartilage, which is articulated into the *sinus* of the *os petrosum*; but betwixt the cartilage which lines the *sinus*, and that which covers the head of this process, there is a third, which adheres to the *ligamentum annulare*, which surrounds this articulation. The motion of the jaw sideways, which is absolutely necessary in chewing, is much facilitated by this loose intervening cartilage. The lower edge of this jaw is called its basis, each end of which is called the angle of the lower jaw.

The lower jaw has four holes, two on its inside near its processes, and two on its outside near its middle. By the internal holes enter a branch of the fifth pair of nerves, an artery from the carotidals, a vein passes out to the jugulars, their branches are spread in the roots of the teeth. By the external holes these same vessels pass, and are distributed upon the chin. It has also sixteen *sinuses* into which the teeth are set.

S E C T.

S E C T. VII.

Of the Teeth.

Of the substance of the teeth.

THE teeth are the hardest and smoothest bones of the body; they are formed in the cavities of the jaws, which are lined with a thin membrane, upon which there are several vessels, through which there passes a thick, viscous, transparent humour, which, as it increases, hardens in the form of teeth, which, about the seventh or eighth month after birth, begin to pierce the edge of the jaw, tear the *periosteum* and gums; which, being very sensible, create a violent pain, and other symptoms incident to children, in the time of tooth-aching.

The teeth begin not to appear all at one time: first the *dentes incisivi* of the upper, and then those of the lower jaw appear, because they are the thinnest and sharpest. After them come out the *canini*, because they are sharper than the *molars*, but thicker than the *incisivi*; and last of all the *molars*, because they are the thickest and bluntest. Of this viscous transparent liquor, which is the substance of the teeth, there are two layers, the one below the other, divided by the same membrane, which covers all the cavity of the jaw: the uppermost layer forms the teeth, which come out first; but about the seventh year of age they are thrust out by the teeth made of the undermost layer, which

which then begin to sprout ; and if these teeth be lost, they never grow again ; but if some have been observed to shed their teeth twice, they have had three lays of this viscous humour. About the one and twentieth year the two last of the *molars* spring up, and they are called *dentes sapientiae*.

The teeth, which are sometimes fourteen, sometimes fifteen, and sometimes sixteen, in each jaw, are of three sorts, the *dentes incisivi*, *canini*, and *molars*. The *incisivi* are the four foremost teeth in each jaw ; they are pretty broad, sharp at their ends, a little convex outwards, and hollow inwards ; they have each a pretty long root, which is a little crooked, and which grows small towards its extremity, that the pressure might not be all directly upon one point of the jaw, but sustained equally by every part which the sides of the root touch.

The *canini* are two in each jaw, one on each side of the *incisivi* ; they are pretty thick and round, and they end in a sharp point ; they have each one root, which is longer than the roots of the *incisivi* ; their proper use is to pierce the aliments, because the fore teeth are not only apt to be pulled outwards by the things we hold and break with them, but likewise because they are more subject to blows than the *molars* ; therefore above two thirds of them are contained in their *alveoli*, or sockets, by which their resistance of all lateral pressures is much greater than that of the *molars*.

The *molars* ordinarily are ten in each jaw ;

jaw ; they are the thickest and biggest of the teeth, their extremities are broad and uneven ; and because the pressure upon them is generally perpendicular, therefore they have sometimes two, sometimes three, and sometimes four roots, which separate a little from one another, that, having a broad basis, they may find the greater resistance from the jaw when they press upon one another in chewing of the aliments ; and the pressure has the less force, seeing the roots are a little crooked outwards, and not in a strait line under the pressure. The last of the *molars* are the biggest and hardest, because we ordinarily thrust the hardest bodies farthest into our mouth ; they are nearest the articulation, because their use, which is to grind the aliments small, requires the greatest strength. The roots of the teeth of the upper jaw are all somewhat larger than those of the under jaw, because the upper jaw is not so strong to resist the pressure of the teeth as the lower is.

S E C T. VIII.

Of the Spine and Vertebrae.

The number of the vertebrae.

BY the *spine* we understand that chain of bones which reaches from the first *vertebrae* of the neck to the *os coccygis* they are twenty-four in number, beside those of the *os sacrum*, seven *vertebrae* of the neck, twelve of the back, and five of the loins ; they ly not in a strait line, for those

those of the neck bend inwards, those of the back outwards, for enlarging the cavity of the *thorax*; those of the loins bend inwards, again, and those of the *os sacrum* outwards, to enlarge the cavity of the basin.

In each *vertebra* we distinguish two parts, The parts of the vertebrae. the body of the *vertebra*, and its processes; the body is softer and more spongy than the processes, which are harder and more solid. The fore part of the body is round and convex, the hind part somewhat concave; its upper and lower side are plain, each covered with a cartilage, which is pretty thick forwards, but thin backwards, by which means we bend our body forwards; for the cartilages yield to the pressure of the bodies of the *vertebrae*, which in that motion come closer to one another. This could not be effected, if the harder bodies of the *vertebrae* were close to one another. Each *vertebra* has three sorts of processes towards its hinder part, two transverse or lateral, one on each side; they are nearer the body of the *vertebra* than the rest. In each of them there is a tendon of the vertebral muscles inserted. Four oblique processes, two on the upper part, and two on the lower; by these the *vertebrae* are articulated to one another; and one acute on the hindermost part of the *vertebra*.

These processes, with the hinder or concave part of the body of the *vertebra*, form a large hole in each *vertebra*: and all the holes answering one another, make a channel for the descent of the spinal marrow, which sends out its nerves to the several

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parts

parts of the body by pairs, through two small holes formed by the jointing of four notches in the sides of each superior and inferior *vertebra*.

Of the articulation of the vertebrae.

The *vertebrae* are articulated to one another by a *ginglymus*; for the two descending oblique processes of each superior *vertebra* of the neck and back have a little dimple in their extremities, wherein they receive the extremities of the two ascending oblique processes of the inferior *vertebrae*; so that the two ascending processes of each *vertebra* of the neck and back are received, and the two descending do receive, except the first of the neck, and last of the back; but the ascending processes of each *vertebra* of the loins receive, and the two descending are received, contrary to those of the neck and back.

The *vertebrae* are all tied together by a hard membrane made of strong and large fibres: it covers the body of all the *vertebrae* forwards, reaching from the first of the neck to the *os sacrum*: there is another membrane which lines the canal, made by the large hole of each *vertebra*, which also ties them all together. Besides, the bodies of each *vertebra* are tied to one another by the intervening cartilages and the tendons of the muscles, which are inserted in their processes, and ty them together behind.

This structure of the *spine* is the very best that can be contrived; for, had it been all one bone, we could have had no motion in our backs; had it been of two or three bones articulated for motion, the *medulla spinalis* must

must have been necessarily bruised at every angle or joint ; besides, the whole would not have been so pliable for the several postures we have occasion to put ourselves in. If it had been made of several bones without intervening cartilages, we should have had no more use of it, than if it had been but one bone. If each *vertebra* had had its own distinct cartilages, it might have been easily dislocated. And lastly, the oblique processes of each superior and inferior *vertebra* keep the middle one, that it can neither be thrust backwards nor forwards to compress the *medulla spinalis*.

Thus much of the *vertebrae* in general ; but because they are not all alike, we shall therefore descend to a more particular examination.

• The seven *vertebrae* of the neck differ from the rest in this, that they are smaller and harder. Secondly, That their transverse processes are perforated for the passage of the vertebral vessels. Thirdly, That their acute processes are forked and strait ; but, besides this, the first and second have something peculiar to themselves.

The first, which is called *atlas*, is tied to the head, and moves with it upon the second semicircularly ; its ascending oblique processes receive the tubercles of the *occiput*, upon which articulation the head is only moved forwards and backwards ; and its descending processes receive the ascending processes of the second *vertebra*. It has no acute process, that it might not hurt the action of the *musculi recti* ; but a small tubercle, to which

Of the *vertebrae* of the neck.

A las.

the small ligament of the head is inserted. In the fore part of its great hole it has a pretty large *sinus*, in which lies the tooth-like process of the second *vertebra* being fastened by a ligament that rises from each side of the *sinus*, that it compresses not the *medulla spinalis*. It has two small *sinuses* in its upper part, in which the tenth pair of nerves and the vertebral arteries ly.

Epistrophæ-
us.

The second is called *epistrophæus*, or *vertebra dentata*; in the middle between its two oblique ascending processes, it has a long and round process like a tooth, which is received into the aforesaid *sinus*; upon it the head with the first *vertebra* turns half round, as upon an axis. The extremity of this process is knit to the *occiput* by a small but strong ligament. A luxation of this tooth is mortal, because it compresses the *medulla spinalis*.

Axis.

The third *vertebra* is called *axis*; and the four following have no name, nor any peculiar difference.

Of the ver-
tebræ of the
back,

The twelve *vertebræ* of the back differ from the rest in this, that they are larger than those of the neck, and smaller than those of the loins; their acute processes slope downwards upon one another: they have in each side of their bodies a small dimple, wherein they receive the round extremities of the ribs, and another in their transverse processes, which receives the little tubercle near that extremity of the ribs. The articulation of the twelfth with the first of the loins is by *arthrodia*, for both its ascending

ascending and descending oblique processes are received.

The five *vertebrae* of the loins differ from the rest in this, that they are the broadest, and the last of them is the largest of all the *vertebrae*. Their acute processes are broader, shorter, and wider from one another, their transverse longer, to support the bowels, and the muscles of the back; they are not perforated as those of the neck, nor have they a dimple or *sinus* as those of the back. The cartilages which are betwixt their bodies are thicker than any of the rest.

The *vertebrae* of the *os sacrum* grow so close together in adults, as that they make but one large and solid bone, of the figure of an *isosceles* triangle, whose basis is tied to the last *vertebra* of the loins, and the upper part of its sides to the *ilia*, and its point to the *os coccygis*. It is concave and smooth on its foreside, but convex and unequal on its backside. It hath five holes on each side, but the nerves pass only through the five on its foreside. Its acute processes, or *spines*, are shorter and less than those of the loins, and the lower is always shorter than the upper.

The *os coccygis* is joined to the extremity of the *os sacrum*: it is composed of three or four bones, of which the lower is still lesser than the upper, till the last ends in a small cartilage; it resembles a little tail turned inwards; its use is to sustain the strait gut; it yields to the pressure of the *fœtus* in women in travail, and midwives use to thrust it backwards, but sometimes rudely and violently,

lently, which is the occasion of great pain, and of several bad effects.

From what has been said, it is easy to understand how the motion of the back is performed: though each particular *vertebra* has but a very small motion, yet the motion of all is very considerable. We have said, that the head moves only backwards and forwards upon the first *vertebra*, and semi-circularly upon the second. The small protuberance which we have remarked in the bone of the hind head, falling upon one another in the first *vertebra*, stops the motion of the head backwards, that it compress not the spinal marrow; and when the chin touches the *sternum*, it can move no farther forwards. The oblique or semi-circular motions are limited by the ligaments which tie the process of the second *vertebra* to the head, and by those which tie the first to the second *vertebra*. The motion of the other *vertebrae* of the neck is not so manifest; yet it is greater than that of the *vertebrae* of the back, because their acute processes are short and strait, and the cartilages which are between their bodies thicker. The twelve *vertebrae* of the back have the least motion of any, because their cartilages are thin, their acute processes are long, and very near to one another; and they are fixed to the ribs, which neither move forwards nor backwards. But the greatest motion of the back is performed by the *vertebrae* of the loins, because their cartilages are thicker, and their acute processes are at a greater distance from one another; for the thicker the cartilages are

are, the more we may bend our body forwards; and the greater distance there is betwixt the acute processes, the more we may bend ourselves backward.

This is the structure and motion of the *vertebrae*, when they are in their natural position; but we find them also in several persons several ways distorted. If the *vertebrae* of the back stick out, such as have this deformity are said to be bunch-backed; and in such the cartilages which are between the *vertebrae* are very thin and hard forwards, but considerably thick backwards, where the oblique processes of the superior and inferior *vertebrae* are at a considerable distance from one another, which distance fills up with a viscous substance. This inequality of the thickness of the cartilages happens either by a relaxation or weakness of the ligaments and muscles, which are fastened to the back-side of the *vertebrae*, in which case their antagonists, finding no opposition, remain in a continual contraction, and consequently there can be no motion in these *vertebrae*. If this deformity has been from the womb, then the bones being at that time soft and tender, the bodies of the *vertebrae* partake of the same inequality as the cartilages. If the bunch be towards one shoulder, for example, towards the right, then the cartilages on that side are very thick, but thin and dry on the other side; on the left side the oblique *apophyses* come close together, but on the right there is a considerable distance betwixt them, and the ligaments and muscles are greatly extended on the right side, but those on the left

left are as much contracted. If the *vertebræ* are distorted inwards, all things have a different face: the cartilages and sometimes the *vertebræ* are very thick forwards, but mighty thin and hard backwards: the acute and oblique processes are very close to one another, and the ligaments upon the bodies of the *vertebræ* are greatly relaxed; but the muscles and ligaments which tie the processes together are very much contracted. These distortions seldom happen in the *vertebræ* of the loins; but such as are so miserable, have little or no motion of their back.

S E C T. IX.

Of the Ossa Innominata.

THE *ossa innominata* are two large bones situated on the sides of the *os sacrum*; in a *foetus* they may be each separated into three pieces, which in adults unite and make but one bone, in which they distinguish three parts. The first and superior part is called *os ilium*; the intestine *ilium* lieth between it, and its fellow. It is very large, almost of a semi-circular figure a little convex, and uneven on its external side which is called its *dorsum*, and concave and smooth on its internal side, which is called its *costa*. Its circumference or edge is called its *spine*. It is joined to the sides of the three superior *vertebræ* of the *os sacrum* by a true future: it is larger in women than in men.

The

The second is the *os pubis*, which is the *Os pubis*, inferior and fore part of the *os innominatum*; it is united to its fellow of the other side by an intervening cartilage, by which means it makes the fore part of the pelvis or basin, of which the *os sacrum* is the back part, and the *ilia* the sides.

The third is the inferior and posterior called *ischium*, or *coxendix*; it has a large cavity called *acetabulum coxendicis*, which receives the head of the thigh bone; the circumference of this cavity is tipped with a cartilage called its *supercilium*, where it joins the *os pubis*; it has a large hole called *foramen ischii & pubis*, about the circumference of which the muscles called *obturator internus* and *externus* arise. And at its lower end it has a large protuberance upon which we sit, and from whence the benders of the leg arise. And a little above this, upon its hinder part, it has another small acute process, betwixt which and the former protuberance lies the *sinus* of the *ischium*, through which the tendon of the *obturator internus* passes.

S E C T. X.

Of the Ribs.

THERE are four and twenty ribs, *Ribs*, twelve on each side of the twelve *vertebræ* of the back; they are crooked, and like to the segments of circles; they grow flat and broad as they approach the *sternum*, but

but the nearer they are to the *vertebræ* they are rounder and thicker, at which end they have a round head, which, being covered with a cartilage, is received into the *sinus* in the bodies of the *vertebræ*; and at the neck of each head, (except the two last ribs), there is a small tubercle, which is also received into the *sinus* of the transverse processes of the same *vertebræ*. The ribs thus articulated make an acute angle with the lower *vertebræ*.

The ribs have each a small canal or *sinus*, which runs along their under sides, in which lies a nerve, vein, and artery. Their extremities, which are fastened to the *sternum*, are cartilaginous, and the cartilages make an obtuse angle with the bony part of the rib; this angle respects the head. The cartilages are harder in women than in men, that they may the better bear the weight of their breasts.

The ribs are of two sorts; the seven upper are called *costæ veræ*, because their cartilaginous ends are received into the *sinus* of the *sternum*. The five lower are called *falsæ*, because they are shorter and softer, of which only the first is joined to the extremity of the *sternum*; the cartilaginous extremities of the rest are tied to one another, thereby leaving greater space for the dilatation of the stomach and entrails. The last of these false ribs is shorter than all the rest; it is not tied to them, but sometimes to the midriff, and sometimes to the *musculus obliquus descendens*.

If the ribs had been articulated with the
bodies

If we suppose the cavity of the *thorax* to be half a sphaeriod, whose semi-axis is the height of the *thorax*, or 15 inches, and the diameter of its greatest circle 12 inches, then the cavity of the *thorax* contains 1130 cubick inches. But in an easy inspira-

tion the *sternum* is raised one tenth of an inch (as I am assured by an exact experiment) upon which account the cavity of the *thorax* is increased to 1150 cubick inches. To this if we add the space the *diaphragma* leaves, which is the segment of a sphere, whose diameter is 15 inches, and the solidity of the segment 183 inches, we shall have 22 inches more, if the *diaphragma* descends but one inch; but if it descends an inch and a half, it leaves room for 52 inches of air to enter: and, if it descends two inches, the cavity of the *thorax* will be increased upon the account of the motion of the *diaphragma* alone 86 inches. So that in the least inspiration we can fairly suppose the lungs are distended with 42 inches of air, and they may be sometimes with above 70 or 100.

S E C T. XI.

Of the Breast-Bone.

Sternum.

THE *sternum* or breast-bone is situated in the middle of the breast; it is composed of seven or eight bones in infants, which at first are cartilaginous, but which harden and unite into three bones after they are seven years old; the substance of these bones is not solid, but somewhat spongy.

The first and uppermost bone is the biggest and largest: it is uneven and rough on its outside, but smoother on its inside, where it has a shallow furrow which gives way for the descent of the wind-pipe. It has a *sinus* lined

lined with a cartilage on each side of its upper end, wherein it receives the heads of the *claviculæ*.

The second is longer and narrower than the first, and on its sides there are several *sinuses*, in which the cartilaginous ends of the ribs are received.

The third is shorter, but broader than the second; it receives into the lateral *sinuses* the extremities of the last true ribs: it terminates into a cartilage which hardens sometimes into a bone, called *cartilago xiphoides*, or *ensiformis*, because it is broad at its upper end, where it joins the third bone, and grows narrower to its extremity, where it is sometimes forked, and sometimes it bends inwards, compresses the upper orifice of the stomach, and causes a great pain and vomiting.

The use of the *sternum* is to defend the heart, and to receive the extremities of the true ribs.

S E C T. XII.

Of the Claviculæ and Scapulæ.

THE *claviculæ* or channel-bones are *Claviculæ*.
 two in number, situated at the basis of the neck, above the breast, one on each side; they are pretty long and small; at one end they are joined to the production of the *scapula*, called *acromion*, by the articulation called *synchondrosis*; at the other end, to the upper end of the *sternum* by
 T the

Of the Claviculæ and Scapulæ.

the articulation called *arthrodia*; they are crooked like an Italian (*f*) for the passage of the vessels which pass under them, and to facilitate the motion of the arms.

Their substance is spongy, therefore they are the more easily broken, and the sooner united when broken: their use is to sustain the *scapulæ* to which the arms are articulated. And because the pectoral muscle, which pulls the arm across the breast, is inserted near the upper end of the *humerus* bone; therefore, if the *clavicula* did not keep the *scapula*, to which the head of the *humerus* is joined, always at an equal distance from the *sternum*, the upper part of the arm, and not the hand, must have been pulled forwards.

The *scapula*, ὀμοπλάτα, or shoulder-blades, are two large and broad bones like the triangle called *scalenum*; they are situated on each side of the upper and back part of the *thorax*. The substance of the *scapula* is thin, but solid and firm; its outside is somewhat convex, and its inside concave; its upper edge is called *costa superior*, and its lower *costa inferior*; its broad end is called its *basis*, which, with the two edges, make the upper and lower angles. They have each three processes, of which the first runs all along the middle of their outside, and it is called their *spine*, that end of the *spine* which receives the extremity of the *clavicula* is called *acromion*. The second process is a little lower than the *acromion*; it is short and sharp like a crow's bill, therefore called *caracoides*; these two processes are tied to
one

one another by a strong ligament which serves to keep the head of the *humerus* in the cavity of the third process, which is called *cervix*. This process is the extremity of the *scapula*, which is opposite to its basis. It has a round *sinus* tipt about its brim with a cartilage, which receives the head of the *humerus*.

The use of the *scapula* is to receive the extremities of the *clavicula* and *humerus*, for the easier motion of the arm, and to give a rise to the muscles which move the arm.

S E C T. XIII.

Of the Bones of the Arms and Hands.

THE first bone of the arm is the *humerus*. The *humerus*, or shoulder bone; it is long and round. Its substance, or fibres, are pretty solid and compact; it has a pretty wide and long cavity in its middle, in which is contained its marrow. At its upper end it has a round head covered with a cartilage, which is received into the cavity of the neck of the *scapula*. In the fore part of the head there is a channel in which a tendon of the *biceps* lies: but because this head is much larger than the cavity, therefore there is a strong ligament which rises from the edge of the cavity of the *scapula*, and forming a bag round the head of the *humerus*, is inserted between the *epiphysis* and the bone. Thus the articulation of the *humerus*.

rus with the *scapula* is an *arthrodia*, or ball and socket, that the arm might have all manner of motions ; but the greatest part of the socket is made of a ligament : for, though the joint would have been stronger, if the cavity had been all of bone, yet the neck of the *humerus* being large and strong, the compass of the arm must have been very small. The lower end of the *humerus*, which is thinner and broader than the other, has two protuberances. The external is received into the extremity of the *radius* ; from the internal the muscles, which bend the fingers and hand, rise ; and between these two protuberances there are two small semi-circular risings, with a middle channel, by which the *humerus* is joined to the *ulna* by a *ginglymus*. On the foreside of these protuberances there is a small *sinus* which receives the fore process of the *ulna* ; and on the backside there is another large *sinus* which receives the *olecranon*.

Ulna.

The *ulna*, or *cubitus*, is a long and hard bone with a cavity in its middle ; it lies on the inside of the fore arm, reaching from the elbow to the wrist ; it is big at its upper end, and grows smaller to its lower end. At its upper it has two processes which are received into the fore and hind *sinuses* of the extremity of the *humerus* : the foremost process is small and short ; the hindmost, called *ολέκρانون*, is bigger and longer ; it stays the fore arm when it comes to a straight line with the arm. Betwixt these processes it has a semi-circular *sinus*, which receives the inner protuberance of the lower end of the *humerus*,

humerus, upon which we bend and extend our fore arm. And along the middle of that there runs a small ridge by which the bone is articulated to the *humerus* by a *ginglymus*. Had the articulation here been an *arthrodia*, the joint must have been much weaker, but the hand could have received no more motion from it than it has now from the shoulder.

The inside of this upper end has a small *sinus* which receives the circumference of the round head of the *radius*. Its lower extremity, which is round and small, is received into a *sinus* in the lower end of the *radius*; and upon this extremity it has a short and small process, from which the ligaments, which tie it to the bones of the wrist, arise; this process serves to keep the bones of the wrist in their place.

The *radius* is another bone of the fore Radius, arm, which accompanies the *ulna* from the elbow to the wrist; in its upper end it has a small cavity which receives the outer protuberance of the *humerus*. The circumference of this cavity rolls in the small *sinus* in the upper end of the *ulna*. Near its lower end, which is bigger than its upper, it has a little *sinus* which receives the end of the *ulna*; and in its extremity it has two *sinuses* which receive the bones of the wrist. Although the *ulna* and the *radius* accompany one another, yet they touch not but at their extremities. They bend from one another in their middle, but they are tied together by a strong and broad membranous ligament.

Of the Bones of the Arms, &c.

The upper end of the *ulna* is the biggest, because upon it, and not upon the *radius*, the articulation at the elbow is performed; but the lower end of the *radius* is biggest, because upon it only the hand is articulated. The *radius* moves either backwards or forwards upon the *ulna*, by which means the palm of the hand is turned either upwards or downwards which two motions are called *pronation* and *supination*. Nor could any other articulation have given these two motions to the hand; for though an *arthrodia* admits of a motion to every side, yet we cannot by that turn the fore part of our arm backwards; and how useless our hands had been without these motions, every one may easily perceive.

Of the
bones of the
carpus.

The *carpus*, or wrist, is made up of eight little bones of a different figure and bigness; they are placed into two ranks, four in each rank. The first rank is articulated with the *radius*. The second with the bones of the *metacarpus*. The last little bone of the first rank lies not at the side of the third, which answers to the bone of the *metacarpus* of the little finger, as all the rest do by one another, but it lies upon it. They are strongly tied together by the ligaments which come from the *radius*; and by the annulary ligament, through which the tendons which move the finger pass. Although this ligament be thought but one, yet it gives a particular case to every tendon which passes through it.

The bones
of the meta-
carpus.

The *metacarpus* is made up of four bones which answer the four fingers; that which sustains

sustains the fore-finger is the biggest and longest; they are round and long, a little convex and round towards the back of the hand, and concave and plain towards the palm. They are hollow in the middle, and full of marrow; they touch one another only at their extremities, leaving spaces in their middle, in which ly the *musculi interossei*. In their end there is a *sinus* which receives the bones of the wrist, and their lower extremity is round, and is received into the *sinus* of the first bones of the fingers.

The bones of the fingers and thumb are fifteen in each hand, three to each finger; they are a little convex and round towards the back of the hand, but hollow and plain towards the palm, except the last where the nails are. The order of their disposition is called first, second, and third *phalanx*. The first is longer than the second, and the second than the third. The upper extremity of the first bone of each finger has a little *sinus* which receives the round head of the bones of the *metacarpus*. The upper extremity of the second and third bones of each finger hath two small *sinuses*, parted by a little protuberance; and the lower extremity of the first and second bones of each finger has two protuberances, divided by a small *sinus*. The two protuberances are received into the two *sinuses* of the upper extremity of the second and third bones; and the small *sinus* receives the little protuberance of the same end of these same bones. The first bone of the thumb is like

to

The bones
of the fin-
gers.

to the bones of the *metacarpus*, and it is joined to the wrist and second of the thumb, as they are to the wrist and first of the fingers. The second bone of the thumb is like the first bones of the fingers, and it is joined to the first and third, as they are to the bones of the *metacarpus*, and second of the fingers. The fingers are moved sideways only upon the first joint.

*Offa f-fa-
moidæa.*

Besides these bones, there are some small ones, called *offa sesamoidæa*, because they resemble the grains of *sesanum*; they are reckoned about twelve in each hand; they are placed at the joints of the fingers, under the tendons of the *flexores digitorum*, to which they serve as so many pulleys.

S E C T. XIV.

Of the Bones of the Thighs, Legs, and Feet.

THE thigh has only one bone, which is the longest of all the bones of the body: Its fibres are close and hard; it has a cavity in its middle; it is a little convex and round on its foreside, but a little hollow, with a long and small ridge called *linea aspera* on its backside. At its upper end it has three *epiphyses*, which separate easily in children.

The first is its extremity, which is a large and round head covered with a cartilage, which is received into the *acetabulum coxendicis*; wherein it is tied by two ligaments. The first is pretty large, and comes from the edge

edge of the *acetabulum*. The second is round and short, it comes from the bottom of the *acetabulum*, and is inserted into the middle of the round head: the part immediately below this round head, which is small, long, and a little oblique, is called its neck. It makes an angle with the body of the bone, by which means the thighs and feet are kept at a distance from one another, and we stand firmer, the *lineæ propensionis* easily falling perpendicular upon any part of the quadrangular space between the feet. Besides this obliquity of the neck of the bone, it conduces much to the strength of the muscles of the thigh, which must have otherwise passed very near to the center of motion.

The second is called *trochanter major*; it is a pretty big protuberance on the external side of the thigh bone, just at the root of the neck; it is rough, because of the insertion of some muscles into it. It has a small dent at its root, into which the *musculi quadragemini*, and the *obturatores*, are inserted. Trochanter major.

The third is called *trochanter minor*; it is on the hind side of the thigh-bone, a little lower and less than the other. These protuberances encrease mightily the force of the muscles, by removing not only their insertions, but likewise the directions, from the center of motion. Trochanter minor.

The lower extremity of the thigh-bone, which is articulated with the *tibia* by *ginglymus*, is divided into the middle by a *sinus* into two heads, or protuberances, the external

ternal and the internal, which are received into the upper *sinuses* of the *tibia*. Through the space that is between the hind parts of these two heads pass the great vessels and nerve which go to the leg; because the upper end of the thigh-bone was articulated by an *arthrodia*, that we might not only move our legs backwards or forwards, but likewise nearer to, or farther from one another; therefore its lower extremity was joined to the *tibia* by *ginglymus*, which is the strongest articulation.

Patella.

In the knee there is a little round bone about two inches broad, pretty thick, a little convex on both sides, covered with a smooth cartilage on its fore-side; it is soft in children, but very hard in those of riper years; it is called *molla*, *patella*, or pan; over it pass the tendons of the muscles which extend the leg, to which it serves as a pulley for facilitating their motion, by removing their direction from the centre of motion.

Tibia.

In the leg there are two bones, the inner and bigger is called *tibia* or *focile majus*; it is hard and firm, with a cavity in its middle; it is almost triangular; its fore and sharp edge is called the shin. In its upper extremity it has two large *sinuses* tipped with a soft and supple cartilage, called *cartilago lunata* from its figure: it runs in between the extremities of the two bones, and becomes very thin at its edge. Like those in the articulation of the lower jaw, it facilitates a small side motion in the knee. The *sinuses* receive the two protuberances of the thigh-bone, and the production which is

is between the *sinuses* of the *tibia* is received in the *sinus* which divides these two protuberances of the *femur*. By bending our knee, we bring our leg in walking in a straight line forwards, which, without this articulation, we could not have done, but, like those who have the misfortune to have a wooden leg, we must have brought our foot about in a semi-circle in going even upon a plain, but more evidently upon an ascent.

On the side of this upper end it has a small knob, which is received into a small *sinus* of the *fibula*; and on its fore part, a little below the *patella*, it has another, into which the tendons of the extensors of the leg are inserted. Its lower extremity, which is much smaller than its upper, has a remarkable process which forms the inner angle, and a pretty large *sinus* divided in the middle by a small protuberance; the *sinus* receives the convex head of the *astragalus*, and the protuberance is received into the *sinus* in the convex head of the same bone. It has another shallow *sinus* in the side of its lower end, which receives the *fibula*.

The outer and lesser bone is called *περὶον* *Fibula*, or *focile minus*: though it be much smaller than the *tibia*, yet it is nothing shorter. It lies on the outside of the leg, and its upper end, which is not so high as the knee, receives the lateral knob of the upper end of the *tibia* into a small *sinus* which has in its inner side. Its lower end is received into the small *sinus* of the *tibia*,
and

and then it extends into a large process which forms the outer angle, embracing the external side of the *astragalus*. The *tibia* and *fibula* touch not one another but at their ends; the space which they leave in their middle is filled up by a strong membranous ligament, and some muscles which extend the feet and toes.

In the foot we distinguish three parts, the *tarsus*, *metatarsus*, and toes.

The bones
of the tarsus
are the ta-
lus.

The *tarsus* is the space between the bones of the leg and the *metatarsus*; it is composed of seven bones.

Astragalus.

The first is called the *astragalus*, or *talus*; in its upper part it has a convex head, which is articulated with the two *foiles* of the leg by *ginglymus*, being it is divided by a little *sinus* which receives the small protuberance in the middle of the *sinus* of the *tibia*. And without this articulation we must always, in going, have trode upon the heel with our fore foot, and upon our toes with our hind foot. The fore part of the *astragalus*, which is also convex, is received into the *sinus* of the *os naviculare*. Below, towards the hind part of its under side, it has a pretty large *sinus*, which receives the upper and hind part of the *os calcis*. But towards the fore part of the same side it has a protuberance which is received into the upper and fore part of the same bone. Betwixt this *sinus* and this protuberance there is a cavity which answers to another in the *os calcis*, in which is contained an oily and mucous sort of substance for moistening the ligaments, and for

cilitation

cilitating the obscure motion of these bones when we go.

The second bone of the *tarsus* is the *cal-Caleaneum, caneum, os calcis*, or heel-bone; it is the biggest of the bones of the *tarsus*. It lies under the *astragalus*, to which it is articulated by *ginglymus*, as we have now described. Behind it has a large protuberance which makes the heel, and into which the *tendo achillis* is inserted; and before it has a cavity which receives a part of the *os cubiforme*.

The third is the *os naviculare*, or *cymbi-Naviculare, forme*; it lies between the *astragalus* and the three *ossa cuneiformia*. Behind it has a large *sinus*, which receives the fore convex head of the first; and before it is convex, distinguished into three heads, which are received into the *sinuses* of the *ossa cuneiformia*.

The fourth, fifth, and sixth are called *ossa Offa cunei-cuneiformia*, because they are large above, ^{formia,} and narrow below; they ly all three at the side of one another; their upper side is convex, and their under hollow, by which means the muscles and tendons in the sole of the foot are not hurt when we go. At one end they have each a *sinus*, which receives the *os naviculare*, and at the other end they are joined to the three inner bones of the *metatarsus*; the inmost of these bones is the biggest, and that in the middle the least.

The seventh bone is called the *os cubi-Os cubiforme, forme*, because of its figure; it lies in the ^{me.} same rank with the *ossa cuneiformia*. Be-

U

hind

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hind it is joined to the *os calcis*, before to the two outer bones of the *metatarsus*, and on its inside is joined to the third *os cuneiforme*.

Metatarsus. The bones of the *metatarsus* are five; that which sustains the great toe is the thickest, and that which sustains the next toe is the longest, the rest grow each shorter than another. They are longer than the bones of the *metacarpus*; in other things they are like them, and they are articulated to the toes, as they are to the fingers.

The bones of the toes. The bones of the toes are fourteen. The great toe hath two, and the rest have each three; they are like to the bones of the fingers, only they are shorter.

In the toes there are sometimes found twelve *ossa sesamoidæa*, as in the fingers.

S E C T. XV.

Of the Nails, and Number of the Bones.

THE nails which are upon the extremities of the fingers and toes seem to be of the same nature as the hoofs of other animals. If you take the hoof carefully off a horse, ox, or hog, you shall see that it is nothing but a bundle of small husks which answer to so many *papillæ* of the skin. From whence we may conclude, that the nails are nothing but the covers or sheaths of the *papillæ pyramidales* of the skin on the extremities of the fingers and toes, which dry, harden, and ly close upon one another:

The Bones of a Skeleton.

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another : their use is to defend the ends of the fingers, when we handle any hard or rugged body.

The Bones of a Skeleton are,

The <i>os frontis</i>	1
<i>Occipitis</i>	1
<i>Ossa parietalia</i>	2
<i>Temporum</i>	2
<i>Ossicula auditus</i>	8
<i>Os ethmoides</i>	1
<i>Sphænoides</i>	1
<i>Mali</i>	2
<i>Maxillare</i>	2
<i>Unguis</i>	2
<i>Nasi</i>	2
<i>Palati</i>	2
<i>Vomer</i>	1
<i>Maxilla inferior</i>	1
<i>Dentes incisivi</i>	8
<i>Canini</i>	4
<i>Molares</i>	20
<i>Os hyoides</i>	1
	—
	61
	—

<i>Vertebræ cervicis</i>	7
<i>Dorsi</i>	12
<i>Lumborum</i>	5
<i>Ossis sacri</i>	6
<i>Os coccigis</i>	3
<i>Scapulæ</i>	2
<i>Claviculæ</i>	2
<i>Costæ</i>	24

U 2

Sternum

The Bones of a Skeleton.

<i>Sternum</i>	1
<i>Ossa innominata</i>	2
	—
	64
	—
The <i>humerus</i>	2
<i>Ulna</i>	2
<i>Radius</i>	2
<i>Ossa carpi</i>	16
<i>Metacarpi</i>	8
<i>Digitorum</i>	30
	—
	60
	—
The <i>os femoris</i>	2
<i>Rotula</i>	2
<i>Tibia</i>	2
<i>Fibula</i>	2
<i>Ossa tarfi</i>	14
<i>Metatarfi</i>	10
<i>Digitorum</i>	28
	—
	60
	—

In all 245

Besides the *ossa sesamoidæa*, which are said to be found to the number of 48.

C H A P. VI.

Of the Muscles which are not yet described.

S E C T. I.

Of the Muscles of the Face.

THE eye-brows have each a muscle called *corrugator*. It arises from the great *canthus* of the orbit, and terminates in the skin about the middle of the eye-brows. Some reckon this pair only a prolongation of the *frontales*; their name declares their use.

The nose has three muscles. The first arises from the end of the upper two bones of the nose, and are inserted into the upper part of the *alæ*. They pull the nose upwards.

The second pair arise from the *os maxillare*, and are inserted into the sides of the *alæ*. They dilate the nostrils.

The third pair arises from the same bone, above the *dentes incisarii*, and are inserted into the extremities of the *alæ*, which they pull downwards.

The muscles of the lips are five proper pair.

The *incisivus*, or *elevator Labii superioris*; it arises from the upper part of the second bone of the upper jaw, and descending obliquely,

liquely, is inserted into the upper lip above the *dentes incisorii*.

Its antagonist is the *triangularis*, or *depressor labii superiores*; it ariseth from the lower edge of the lower jaw, between the *masseter* and the *quadratus*, and ascendeth by the angle of the mouth to the upper jaw.

The *caninus*, or *elevator labii inferioris*; it ariseth from the second bone of the upper jaw, below the *incisivus*; it descends and passes under the insertion of the *zygomaticus*, and is inserted into the under lip. This muscle is assisted by another small but strong pair of muscles, first observed by Mr. Cowper, and by him called *elevator labii inferioris*: they arise from the gums of the *dentes incisorii*, and descending directly, are inserted into the lower part of the skin of the chin. When they act, they pull the skin of the chin, and consequently thrust the lower lip upwards.

Its antagonist is the *quadratus*, or *depressor labii inferioris*; this is some thin fleshy fibres, which ly immediately under the skin upon the chin, on each side of the former; they arise from the edge of the fore part of the under jaw, and are inserted into the upper lip.

There are three muscles common to both the lips.

The first and the second are *zygomatici*, one on each side; they come from the *os zygoma*, and going obliquely, they are inserted near the angles of the lips. When one of these muscles acteth, it draws both lips obliquely

liquely to a side; they receive often some fibres from the *caninus*.

The third is the *orbicularis*, or *sphincter labiorum*; it furrounds the lips with orbicular fibres; when it acteth, it draws the lips.

There is one muscle on each side, common to the lips and cheeks, which is the *buccinator*; it lies under the other muscles; it makes the inner substance of the cheeks; its fibres run from the *processus coronæ* of the lower jaw to the angle of the mouth, and they adhere to the upper part of the gums of both jaws. Through its middle pass the upper *ductus salivales*; by this muscle we contract the cavity of our mouth, and thrust the meat between our teeth.

The muscles of the lower jaw are twelve pair, six on each side.

The first is the *temporalis*, or *crotaphites*; it arises by a semi-circular fleshy beginning from a part of the *os frontis*, from the lower part of the *parietalia* and upper part of the *temporale*. From thence they go under the *zygoma*, and gathering together as to their centre; they are inserted by a short but strong tendon into the *processus coronæ* of the lower jaw.

The second is the *masseter*; it is a thick and short muscle; it arises from the *zygoma*, and from the first bone of the upper jaw, and is inserted into the lower edge of the lower jaw, from its external angle to its middle. Its fibres run in three directions; those which come from the *zygoma* run obliquely to the middle of the jaw; and those from

from the first bone of the upper jaw cross the former, and run to the angle of the lower jaw; and the fibres which are in its middle run in a perpendicular from their origin to their insertion. These two muscles pull the jaw upwards.

The third is the *pterygoideus internus*; it arises from the internal part of the *processus pterygoideus*, and descends to be inserted into the inferior part of the internal side of the lower jaw, near its angle: When this muscle acteth, it draweth the jaw to a side.

The fourth is the *pterygoideus externus*; it arises from the external part of the same process, and goes backwards to be inserted between the *processus condiloides* and the *corona* on the inside of the lower jaw. This muscle pulleth the lower jaw forwards.

The fifth is the *quadratus*; this is a broad membranous muscle, which lies immediately under the skin; it ariseth from the upper part of the *sternum*, from the *claviculae*, and from the *acromium*; it covereth all the neck, and adheres firmly to the lower edge of the lower jaw; and, being produced, it covers also the lower part of the cheeks. When this muscle acteth, it pulleth the cheeks and jaw downwards.

The sixth is the *digastricus*; it ariseth fleshy from the upper part of the *processus mastoideus*, and descending, it contracts into a round tendon, which passes through the *stylohyoidæus*, and an annular ligament which is fixed to the *os hyoides*; then it grows fleshy again, and ascends to the middle of the edge of the lower jaw, where it

is inserted. When this muscle acteth, it pulleth the lower jaw down, by help of the annular pulley, which alters its direction.

S E C T. II.

Of the Muscles of the Head.

THE head is lifted up or pulled backwards by four pair of muscles.

The first is the *splenius*, which ariseth from the four upper spines of the *vertebrae* of the back, and from the two lower of the neck; and, ascending obliquely, it adheres to the upper transverse processes of the *vertebrae* of the neck, and is inserted into the upper part of the *occiput*.

The second is the *complexus*; it ariseth from the transverse processes of the *vertebrae* of the neck, and, ascending obliquely, it adheres to the spines of the same *vertebrae*, and is inserted into the *occiput*: When one of these muscles acteth, it moves the head backwards to one side.

The third is the *rectus major*; it ariseth from the spine of the second *vertebra* of the neck, and is inserted into the lower part of the *occiput*.

The fourth is the *rectus minor*; it lies under the *major*: it cometh from the back part of the first *vertebra* of the neck, and is inserted below the former: they nod the head backwards.

The semi-circular motion of the head is performed by

The

Of the Muscles of the Head.

The *obliquus inferior*, which comes from the spine of the second *vertebra* of the neck, and is inserted into the transverse process of the first.

The *obliquus superior* comes from the transverse process of the first *vertebra* of the neck and is inserted into the lateral and inferior part of the *occiput*.

The *mastoidæus* arises fleshy from the upper part of the *sternum* and extremity of the *claviculæ*; and, ascending obliquely, it is inserted into the back part of the *processus mamillaris*. When either of these muscles act, the head turneth to the contrary side.

The head is bended forwards by

The *rectus internus major*, which arises from the fore part of the five interior transverse processes of the *vertebræ* of the neck, and is inserted into the foremost *appendix* of the occipital bone, near its great hole.

The *rectus internus minor*, observed and described by that accurate anatomist Mr. Cowper, in his most exact treatise of the muscles; it lies on the fore part of the first *vertebra*, like the *rectus minor* on the back part, and is inserted into the *anterior appendix* of the *os occipitis* immediately under the former. These nod the head forwards, being antagonists to the *recti minores*.

Fallopious has described another pair, called *recti laterales*, which come from the transverse processes of the first *vertebra*, and are inserted near the *processus mamillaris*; they help to move the head a little to one side.

SECT.

S E C T. III.

Of the Muscles of the Neck.

THE neck is bended and extended ; it is bended by two pair of muscles.

The first is the *longus*, which is fastened to the bodies of the five upper *vertebræ* of the back, and to all those of the neck ; but because the last are more moveable than the first, therefore they are its insertion, and those of the back its origination.

The *scalenus* arises from the first and second ribs ; and, ascending, is inserted into all the transverse processes of the neck, except the first. This muscle seems to be three ; yet I will not increase their number. It is perforated for the passage of the veins, arteries, and nerves ; because the neck is more easily moved than that part of the ribs to which they are fastened ; therefore it is justly reckoned among the benders of the neck.

The neck is extended by the *musculi vertebrales*, of which afterwards.

S E C T. IV.

Of the Muscles of the Scapula.

THE *scapula* is moved backwards and forwards, upwards and downwards, by four muscles.

The first is the *serratus minor anticus* ; it
arise

Of the Muscles of the Scapula.

arise thin and fleshy, from the second, third, fourth, and fifth superior ribs, and, ascending obliquely, it is inserted fleshy into the *processus coracoideus* of the *scapula*, which it draws forwards; it helps also in respiration.

The second is the *trapezius*, or *cucullaris*, because with its fellow it represents a cowl; it arises from the *occiput* above the *splenius*, from the spines of the *vertebræ* of the neck and from the eighth superior of the back, and is inserted into the spine of the *scapula* to the *acromium* and *clavicle*; it moves the *scapula* obliquely upwards, directly backwards, and obliquely downwards, according to the three directions of its fibres.

The third is the *rhomboides*, so called from its figure; it lies under the *cucullaris*; it arises from the two inferior spines of the neck and four superior of the back; and is inserted fleshy into the whole basis of the *scapula* which it draws backwards.

The fourth is the *levator scapulæ*; it arises from the second, fourth and fifth transverse processes of the neck by so many distinct beginnings, which unite, and are inserted into the superior angle of the *scapula* which it draws upwards: it is also called *musculus patientiæ*, because those who are in any ways grieved use it.

These muscles may move the arm, those of the arm move it, because of the connection of the two bones: they help also in respiration.

S E C T. V.

Of the Muscles of Respiration; and of the Benders and Extensors of the Vertebrae.

THE cavity of the *thorax* is dilated and contracted in respiration, by nine and twenty pair of muscles; five and twenty pair pull the ribs up, three pair accelerate their motion downwards, and one pair, *viz.* the *diaphragma*, helps both in the one and the other; this last we have described already.

The muscles which dilate the *thorax* in inspiration are,

The *intercostales externi et interni*; they are in number four and forty, one of each sort between every two ribs; they arise from the lower edge of each superior rib, and are inserted into the upper edges of each inferior rib. Their fibres decussate one another; those of the external run obliquely from the back part forwards, but those of the internal from the fore part backwards.

The *sabclavius* arises from the lower side of the half of the *clavicula* that is nearest the *acromium*, and descends obliquely to be inserted into the upper part of the first rib, near the *sternum*.

The *ferratus anticus major*; it comes from the whole basis of the *scapula*, and is inserted into the seven true ribs, and first of the false ribs, by so many distinct portions, which represent the teeth of a saw. The

X

obliquus

Of the Muscles of Respiration, &c.

obliquus descendens of the *abdomen* lies between the spaces of its lower indentation.

The *serratus posticus superior*; it ariseth by a broad and thin tendon from the two inferior spines of the *vertebræ* of the neck, and the three superior of the back; and growing fleshy, it is inserted into the second, third, and fourth ribs by so many distinct indentations.

When all these muscles act, they draw the ribs upwards, bringing the ribs to right angles with the *vertebræ*; and consequently the cavity of the *thorax* must be wider and shorter: but because at the same time the *diaphragma* contracts, therefore the cavity is also longer.

The muscles which contract the cavity of the *thorax* are,

The *triangularis*; it arises from the lower part of the inside of the *sternum*, and is inserted into the cartilages where they join the bones of the fourth, fifth, sixth, and sometimes seventh true ribs.

The *serratus posticus inferior* arises by a broad and thin tendon from the three inferior spines of the *vertebræ* of the back, and from the two superior of the loins; its fibres ascending obliquely, grow fleshy, and are inserted by four indentations into the four last ribs.

The *sacro-lumbus*; it arises fleshy from the superior part of the *os sacrum*, posterior part of the spine of the *ilium*, and from all the spines and transverse processes of the *vertebræ* of the loins: it gives a small tendon to the posterior part of each rib,
near

near its root, where a small bundle of fleshy fibres arises, and unites with each ascending tendon to the third, fourth, fifth, and sixth *vertebra* of the neck. These muscles are of small force, and seem only to accelerate the motion of the ribs, which fall down by their own gravity, and the elasticity of the ligaments, by which they are bound to the *vertebrae*.

The muscles of the back and neck are very numerous, and variously described by authors. I shall not multiply them, but take all that have the same direction and disposition for the same muscle, though perhaps it may be divided into as many muscles as there are *vertebrae*. The first is

The *longissimus dorsi*. This muscle at its beginning is not to be separated from the *sacrolumbus*, arising with it from the back part of the spine of the *ilium*, and upper part of the *os sacrum*; and as it ascends, it gives tendons to each transverse process of the *vertebrae* of the loins, *thorax*, and neck. When these muscles act, they keep the body erect. Under this lies

The *transversalis dorsi*, of which authors commonly make three, *viz.* the *sacer*, the *semispinatus*, and *transversalis colli*. This muscle arises from the *os sacrum*, and from all the transverse processes of the *vertebrae* of the loins, back, and neck, except the two first; and is inserted by so many distinct tendons to all their superior spines: this muscle moves the whole spine obliquely backwards.

The *inter-spinalis*, of which the first part

is called (by Bidlow) *semi-spinalis*, and the other part (by Mr. Cowper, who first observed them) *inter-spinalis colli*: they arise partly fleshy and partly tendinous from the spines of the loins and the inferior of the *thorax*, and are inserted into the fifth, sixth, and seventh spines of the *thorax*. These join the *longissimus dorsi*. The other part arises from the superior parts of each double spinal process of the neck, except that of the second *vertebra*, and is inserted into the inferior parts of all the said spines. These muscles draw the spines of the *vertebræ* nearer one another.

The *spinalis colli*. It arises from the five superior transverse processes of the *vertebræ* of the *thorax*, and the superior of the neck, and is inserted with its fellow into the inferior part of the second *vertebra* of the neck. They pull the neck directly backwards.

The *quadratus lumborum*. It ariseth from the posterior part of the spine of the *ilium*, and is inserted into the inside of all the transverse processes of the *vertebræ* of the loins. This muscle moves the body upon the loins to one side, and both together help the *rectus abdominis* in bending our body forwards.

The *vertebræ* of the neck are bended by two pair of muscles, which have been already described. The *vertebræ* of the back have no benders, and those of the loins are bended by the muscles of the lower belly, and by one proper pair, which is called the *psoas parvus*; it arises fleshy from the insides of the upper *vertebræ* of the loins, and
it

it has a thin and broad tendon which embraces the *psoas* of the thigh, and which is inserted into the *os innominatum*, where the *os pubis* and *ilium* join together.

S E C T. VI.

Of the Muscles of the Humerus, or Arm.

THE arm moves five different ways, upwards, downwards, forwards, backwards, and round.

The arm is lifted upwards by the *deltoides*, *supra spinatus*, *coracobrachialis*.

The *deltoides* is of a triangular figure; it come from all the *spina scapulae*, from the *acromium*, from the external half of the *clavicula*; from all these places its fibres drawing together, pass above the articulation of the *humerus*, and are inserted by a short tendon, four fingers below the head of the same bone, almost on its external side. Steno shews that this muscle is composed of twelve simple muscles: according to the direction of its fibres, it pulls also the arm a little forwards and backwards.

The *supra spinatus* rises fleshy from all the basis of the *scapula*, that is above the spine. It fills all that space between the upper side of the *scapula* and its spine, to which too it is also attached: it passes above the *acromium*, over the articulation of the *humerus*, and is inserted into the neck of the *humerus*, which it embraces by its tendon.

The *coracobrachialis* rises from the *processus*

Of the Muscles of the Humerus.

musculus coracoideus scapulae by a tendinous beginning; and passing over the articulation, it is inserted into the middle and internal part of the *humerus*.

The *teres major* and the *latissimus dorsi* pull the arm downwards.

The *teres major* rises from the lower angle of the *scapula*, and is inserted with the following a little below the head of the *humerus*.

The *latissimus dorsi*, or *aniscaptor*, with its fellow, covers almost all the back. It hath a thin and large tendinous beginning, which comes from the posterior part of the spine of the *ilium*, from the superior spines of the *os sacrum*, from all the spines of the *vertebrae* of the loins, and from the seven lower of the *thorax*; it passes by the inferior angle of the *scapula*, from which some of its fleshy fibres sometimes arise, and is inserted with the *teres major* by a strong and broad tendon.

The *pectoralis* moves the arm forwards; it ariseth by a fleshy and semi-circular beginning from the inner half of the *clavicula* from the six superior ribs; it covereth a great part of the breast, and is inserted by a short but strong and broad tendon into the upper and inner part of the *humerus*, between the *biceps* and *deltoides*. Its fibres near their insertion decussate each other. Those which come from the *clavicle* and first ribs are on the lower side of the tendon; and those from the inferior ribs are on the upper side of the tendon.

The arm is drawn backwards by the *infra spinatus*,

spinatus, the *transversalis*, and the *sub-scapularis*.

The *infra spinatus* covers all the space that is between the spine of the *scapula* on its inferior side; and passing between the spine and the *teres minor*, it is inserted into the neck of the *humerus*.

The *transversalis*, or *teres minor*, comes from the inferior edge of the *scapula*, upon which it runs between the former and the *teres major*, and is inserted into the neck of the *humerus*.

The *sub-scapularis* covers all the internal side of the *scapula*; it rises from the *basis*, from its upper end, and is inserted into the *humerus*; it draweth the arm towards the side.

The tendons of these muscles surround the *humerus* at the neck. When all these muscles move together they move the arm towards the side.

S E C T. VII.

Of the Muscles of the Cubitus and Radius.

THE *cubitus* is bended and extended by six muscles; the *biceps* and *brachieus internus* bend it; the *longus*, *brevis*, *brachieus externus*, and the *anconæus*, extend it.

The *biceps* is so called, because it hath two heads, of which one rises from the upper edge of the cavity of the head of the *scapula*. This head is round and tendinous, and is inclosed in the channel in the head of the

the *humerus*. The other arises from the *processus coracoides*, it is broad and tendinous; and both together unite about the middle and fore part of the arm, and make one belly, which is inserted, by a strong and round tendon, into the tubercle at the upper end of the *radius*. Some of the fibres of this tendon form a large and thin *aponeurosis*, which covers all the muscles of the *radius* and fingers externally. Care ought to be taken in blood-letting, not to cut a-cross, but according to the length of the fibres of the *aponeurosis*.

The *brachialis internus* lies partly under the *biceps*; it rises by a fleshy beginning from the middle and internal part of the *humerus*, and is inserted into the upper and fore part of the *radius* by a very short but strong tendon.

The *longus* is the first of those which extend the *cubitus*; it ariseth from the inferior *costa* of the *scapula*, nigh its neck, and passeth betwixt the two round muscles; it descendeth upon the back side of the *humerus*, where it joins with the two following.

The *brevis* arises from the superior and posterior part of the *humerus*.

The *brachialis externus* arises about the middle and posterior part of the *humerus*. These three join their fleshy fibres together, and, being externally tendinous, they cover all the elbow, and are inserted into the *olecranium*.

The *anconius* is a small muscle which arises from the back part of the extremity of the *humerus*, passes over the elbow, and is inserted

inserted into the lateral and internal part of the *ulna*, about three or four fingers breadth below the *olecranium*.

The *radius* hath four muscles, two *pronatores*, which turn the palm of the hand downwards, they are the *rotundus* and the *quadratus*; and two *supinatores*, which turn the palm upwards, they are called *longus* and *brevis*.

The *rotundus* arises fleshy from the internal extuberance of the *humerus*, and goes obliquely to be inserted in the middle and external part of the *radius*.

The *quadratus* arises by a broad and fleshy beginning from the lower and internal part of the *ulna*; it passes over the ligament that joins the *radius* to the *ulna*, and is inserted as broad as its beginning into the external and lower part of the *radius*.

The first of the *supinatores* is the *longus*; it ariseth by a fleshy beginning, three or four fingers breadth above the external extuberance of the *humerus*. It lies all along the *radius*, to whose inferior and external part it is inserted by a pretty broad tendon.

The second is the *brevis*; it cometh from the external and upper part of the *ulna*, and passing round the *radius*, it is inserted into its upper and fore part, below the tendon of the *biceps*.

S E C T. VIII.

Of the Muscles of the Palm of the Hand, and of the Wrist.

THE muscles of the palm of the hand are two.

The first is that which is commonly known by the name of *palmaris*; it arises from the internal extuberance of the *humerus*, and by a long and slender tendon it passes above the *ligamentum annulare* to the palm of the hand, where it expands itself into a large *aponeurosis*, which cleaves close to the skin above, and to the sides of the bones of the *metacarpus* below, and the first *phalanx* of the fingers, by which means it makes four cases for the tendons of the benders of the fingers to pass through. This muscle is sometimes, but the *aponeurosis* is always, there.

The second may be called *palmaris brevis*; it lies under the *aponeurosis* of the first; it arises from the bone of the *metacarpus* that sustains the little finger, and from that bone of the *carpus* that lies above the rest. It goes transversely, and is inserted into the eighth bone of the *carpus*. The first assists the hand to grasp any thing closely, and the second makes the palm of the hand concave.

The muscles of the wrist are four, two internal for bending of it, and two external for extending it.

The

The first is the *cubitæus internus*; it arises from the internal extubérance of the *humerus*, and upper part of the *ulna*, upon which it runs all along till it pass under the *ligamentum annulare*, and is inserted by a strong and short tendon into the fourth of the first order of the *carpus*.

The second is the *radiæus internus*, which comes from the same part with the former, and, lying upon the *radius*, it is inserted into the first bone of the *metacarpus* that sustains the fore finger. These two muscles bend the wrist.

The third, which is the first of the *extensors*, is the *cubitæus externus*; it comes from the external extubérance of the *humerus*, and passing its tendon under the *ligamentum annulare*, it is inserted into the fourth bone of the *metacarpus* that sustains the little finger.

The fourth is the *radiæus externus*, or *bicornis*, which is two distinct muscles; the first arises from above the external protubérance of the *humerus*, and the second from the lowermost part of the external protubérance. They both ly along the external part of the *radius*; they pass under the annular ligament, and the one is inserted into the bone of the *metacarpus* that sustains the fore finger, the other to that which sustains the middle finger; these two extend the wrist.

S E C T. IX.

Of the Muscles of the Fingers.

TH E fingers are bended and extended, they are drawn to and from the thumb by several muscles. The muscles which bend them are the *sublimis* and the *profundus*.

The *sublimis*, otherwise called *perforatus*, arises from the internal protuberance of the *humerus*, and from the upper and fore part of the *radius*: it divides into four parts, which send four tendons, which pass under the annular ligament to be inserted into the upper part of the second *phalanx* of each of the four fingers. Each of these tendons, as they pass the first internode of the fingers, have a slit in their middle, for the passage of the tendons of the *profundus*, which lies under the *sublimis*, it arises fleshy from the upper part of the *ulna*, and from the ligament that joins this bone to the *radius*. The lower part of its body is outwardly tendinous; it divides into four round tendons, which pass under the annular ligament, and through the slits of the former tendons, to be inserted into the third bone of the fingers.

The muscles have this in particular, that the tendons of the uppermost give passage to the tendons of the lower: and their tendons upon the palm of the hand are enclosed in cases from the *aponeurosis palmaris* and upon the fingers in strong membranous

cases, which are fixed to the sides of each finger.

The *extensor digitorum communis* arises from the external protuberance of the *humerus*, and at the wrist it divides into three flat tendons, which pass under the annular ligament, to be inserted into all the bones of the fore, middle, and ring finger. These tendons, near the first internodes of the fingers, give some tendinous fibres to each other, and some also to the *interossei*.

The *lumbricales*, or *vermiculares*, are small muscles which rise from the tendons of the *profundus*, and are inserted into the first internodes of each finger. On their internal sides next the thumb they assist in bending the first joint of the fingers.

The *interossei*, some reckon six, and others, more justly, eight; they are contained betwixt the spaces of the bones of the *metacarpus*: the one half of them lies betwixt the spaces that these bones leave towards the palm of the hand; they are the internal *interossei*; they arise from the upper part of the bones of the *metacarpus* next the *carpus*, and they are inserted on the internal sides of the first bones of the fingers, with the *lumbricales*; they are the *abductores digitorum*, for they bring the fingers to the thumb. The other half are contained in the spaces that the bones of the *metacarpus* leave on the back of the hand; they rise from the upper part of the bones of the *metacarpus* next the *carpus*, and they are inserted on the external sides of the first bones of the fingers; and these are the *abductores digi-*

Of the Muscles of the Fingers.

digitorum, for they draw the fingers from the thumb.

The thumb is bended by two muscles. The first arises from the internal extubérance of the *humerus*, from the middle and inner part of the *radius*, by two different orders of fleshy fibres; and passing under the *ligamentum annulare*, its tendon is inserted into the third bone of the thumb. The second arises from the bones of the *carpus*, from the annular ligament, and is inserted into the second internode of the thumb: these two muscles are called *flexores pollicis*.

It is extended by three muscles, which are,

The *extensor primi internodii pollicis*. It arises from the upper and external part of the *ulna*; it passes obliquely over the tendon of the *radius externus*, and is inserted near the second joint of the thumb.

The *extensor secundi internodii pollicis*. It arises from the upper and internal part of the *radius*, and is inserted into the upper part of the second bone of the thumb.

The *extensor tertii internodii pollicis*. It arises from the *ulna*, a little below the first *extensor* and is inserted into the third bone of the thumb.

The *tenar* draws the thumb from the fingers; it makes that part which is called *mons lunæ*; it ariseth from the *ligamentum annulare*. and first bone of the *carpus*, and is inserted into the external side of the thumb.

The *antitenar* draws the thumb to the fingers;

fingers; it riseth from the bone of the *metacarpus* that sustains the fore finger, and is inserted into the first bone of the thumb.

The *abductor indicis* arises from the fore part of the first bone of the thumb, and is inserted into the bones of the fore finger; it draws this finger to the thumb.

The *index* hath a particular *extensor*, which comes from the middle and external part of the *ulna*; it passeth under the annular ligament, and is inserted into the third bone of the fore finger, where it joins the *extensor communis*.

The little finger hath two proper muscles, the one draws it from the other fingers, the other extends it. The first is called *hypotenar*; it riseth from the fourth bone of the second rank of the bones of the *carpus*, and from the *ligamentum annulare*, and is inserted externally into the first bone of the little finger; this draws it from the other fingers.

The *extensor* of the little finger arises from the external protuberance of the *humerus*, and from the upper part of the *ulna*; it passes under the annular ligament, and is inserted into the third bone of the little finger.

S E C T. X.

Of the Muscles of the Thigh.

THE thigh is bended and extended, moved outwards and inwards, obliquely and circularly, by thirteen muscles.

Of the Muscles of the Thigh.

It is bended by the *psoas*, *iliacus*, and *pectineus*.

The *psoas* arises from the internal side of the transverse processes of the *vertebrae* of the loins, within the *abdomen*; and descending upon part of the internal side of the *ilium*, it is inserted into the lower part of the little *trochanter*.

The *iliacus* arises from the internal cavity of the *os ilium*, and descending, it joins with the former, with which it is also inserted.

The *pectineus* arises from the external part of the *os pubis*, and is inserted a little below the lesser *trochanter*.

The thigh is extended by the *glutæus major*, *medius*, and *minor*.

The *glutæus major* arises semi-circularly from the *os coccygis*, the spines of the *sacrum*, from the spine of the *ilium*, and from a strong ligament that runs between the *sacrum* and *tubercle* of the *ischium*; and descending, it is inserted into the *linea aspera*, four fingers breadth below the great *trochanter*.

The *glutæus medius* arises from all the spine of the *ilium* under the former, and is inserted into the superior and external part of the *trochanter*.

The *glutæus minor* arises from the lower part of the external side of the *ilium*, under the former, and is inserted at the superior part of the great *trochanter*.

The thigh is moved inwards, or they are both brought together by the *triceps*, which hath

hath three originations, and three insertions, and may be divided into three muscles.

The first arises from the *os pubis*, and is inserted above the second in the *linea aspera* in the thigh-bone.

The second arises from the lower part of the *os pubis*, and is inserted about the middle of the *linea aspera*.

The third arises from the *os pubis*, where it joins the *os ischium*, and is inserted from a little below the second to the internal and lower *apophysis* of the thigh-bone. When they act, they pull the thigh-bone inwards, and turn it a little outwards.

The thigh is turned outwards by the *quadrifemini*.

The first is the *pyriformis*, or *iliacus externus*; it rises round and fleshy from the inferior and lateral part of the *os sacrum*, and is inserted with

The second and third called *gemini*, which arise from the protuberance of the *ischium*, and are inserted with the first in the dent at the root of the great *trochanter*.

The fourth is the *quadratus*; it comes from the protuberance of the *ischium*, and is inserted into the outside of the great *trochanter*.

The thigh is moved circularly and obliquely when these muscles act successively, but particularly by the two *obturatores*.

The *obturator internus* comes from the internal circumference of the hole that is between the *ischium* and *pubis*; and passing through the sinuosity of the *ischium*, it is inserted into the dent of the great *trochanter*.

Its tendon lies between the *gemini*; it turns the thigh to the outside.

The *obturator externus* comes from the external circumference of the same hole as the former: it embraces the neck of the thigh-bone, and passes under the *quadratus* to the small cavity of the great *trochanter*.

S E C T. XI.

Of the Muscles of the Leg.

THE leg is bended by four muscles, and extended by four others. The muscles which bend it are,

The *semi-nervosus*, which arises from the protuberance of the *ischium*, and is inserted by a round tendon into the internal part of the *epiphysis* of the *tibia*.

The *semi-membranosus* arises tendinous from the protuberance of the *ischium*, immediately below the former, and is inserted by a large tendon into the upper and back part of the *tibia*.

The *biceps*, so called because it has two heads, of which one comes from the tuberosity of the *ischium*, the other from the middle of the *linea aspera*, both which join together, and are inserted by one tendon into the superior and external part of the *perone*.

The *gracilis* arises from the union of the *os pubis* and *ischium*, and descending by the inside of the thigh, it grows tendinous, and

is inserted into the superior and internal side of the *tibia*.

The leg is extended by four muscles, which are,

The *rectus*; it arises from the lower part of the spine of the *ilium*, and descending between the two following, it is inserted with them.

The *vastus externus*, which comes from the root of the great *trochanter*, and part of the *linea aspera*.

The *vastus internus*, which arises from the root of the lesser *trochanter*.

The *cruræus*, which comes from the fore part of the thigh-bone, between the great and lesser *trochanter*; and lying close upon the bone, it joins its tendon with the three former, which all together make one broad tendon, which passes over the *patella*, and is inserted into the little tuberosity on the upper and fore part of the *tibia*.

The leg is moved obliquely by three muscles.

The *longus*, or *sartorius*; it arises from the inferior part of the spine of the *ilium*, and running obliquely by the inside of the thigh, is inserted into the internal side of the *tibia*, three or four fingers breadth below its upper extremity. By this muscle we throw one leg and thigh cross another.

The *popliteus*; it arises from the external and inferior protuberance of the thigh-bone, and passing over the joint obliquely, is inserted into the superior and internal part of the *tibia*. This assists in bending of the leg, and turns it a little inwards.

The

Of the Muscles of the Foot:

The *membranofus*, or *fascia lata*, which arises fleshy from the fore part of the spine of the *ilium*, and a little below it becomes membranous or tendinous, and covers almost all the muscles of the thigh and leg down to the foot. This muscle helps in extending of the leg, and turns the leg a little outwards.

S E C T. XII.

Of the Muscles of the Foot.

THE foot is bended by the *tibialis peronæus anticus*.

The *tibialis anticus* arises fleshy from the upper and fore part of the *tibia*, and adhering to the external side of the *tibia*, as it descends it passes under the *ligamentum annulare*, and is inserted into the *os cuneiforme*, which answers to the great toe.

The *peronæus anticus* is joined to the *posticus* at its origination, which is from the upper and external half of the *perone*; and running through the channel which is in the external angle, it is inserted into the *os metatarsi* that sustains the great toe.

The foot is extended by four muscles.

The first and second are the *gastrocnemius*, or *gemellus*, which, with the *soleus*, make the calf of the leg. The one arises from the back part of the internal protuberance of the thigh-bone, the other from the same part of the external protuberance of the same bone: they have two large fleshy bellies,

lies, which join and make one tendon with the following, which is inserted into the *os calcis*.

The third is the *soleus*, which lies under the former; it arises from the upper and back part of the *tibia* and *perone*; and descending, it joins its tendon with the former. The tendon of these three muscles is big and strong, called *tendo Achillis*.

The fourth is the *plantaris*; it has a fleshy origination from the back part of the external protuberance of the thigh-bone, and descending a little way between the *gemellus* and *soleus*, it becomes a long and slender tendon, which marches by the inside of the great tendon, and at the sole of the foot is expanded into a large *aponeurosis*, which has the same use, situation, and connection, as that of the palm of the hand.

The foot is moved sideways by two muscles.

The *tibialis posticus*, which arises from the superior and back part of the *tibia* and *fibula*, and membrane that ties them together; and descending by the hind part of the *tibia*, passes through the fissure of the inner ancle, and is inserted into the under side of the *os naviculare*; it moveth the foot inwards.

The *peroneus posticus* arises from the superior and external part of the *perone*; and descending, it passes through the fissure of the external ancle under the sole of the foot, to be inserted into the *os metatarsi* that sustains the little toe. When this muscle acteth, it pulleth the foot outwards.

SECT.

S E C T. XIII.

Of the Muscles of the Toes.

THE four lesser toes are bended, and extended, and moved sideways.

They are bended by the *perforans* and *perforatus*.

The *perforans* arises from the upper and back part of the *tibia*, and passing under the inner ancle and ligament that ties the *tibia* and *os calcis* together, it divides into four tendons, which pass through the holes of the *perforatus*, and are inserted into the third bones of each lesser toe. There is a *massa carnea* that arises from the *os calcis*, which joins the tendons of this muscle where the *lumbricales* begin.

The *perforatus*, or *flexor brevis*, arises from the inner and lower part of the *os calcis*, and is inserted by four tendons into the second *phalanx* of each toe. These tendons are perforated, to give way to the tendons of the *perforans*.

The toes are extended by the *longus* and *brevis*.

The *longus* comes from the superior and external part of the *tibia*, and from the upper part of the *fibula*: and, being divided into five tendons, it passes under the *ligamentum annulare*, and is inserted into the third bones of the lesser toes, and into the *os metatarsi* that sustains the little toe.

The *brevis* lies under the tendons of the former, and arises from the external and fore

fore part of the *os calcis*, and is inserted by five tendons into the second *phalanx* of the toes : these tendons cut the tendons of the former at acute angles.

The four *lumbricales* arise from the tendons of the *perforans*, and are inserted into the inside of the lesser toes.

The eight *interossei*, which ly betwixt the bones of the *metatarsus*, have the same situation, use, origination, and insertion, as those of the hand.

The *abductor minimi digiti* arises from the external part of the *os calcis*, and lying upon the outside of the *os metatarsi*, that sustains the little toe, it is inserted into the upper part of the first bone of the same toe externally.

The great toe is bended, extended, and moved sideways by several muscles.

The *flexor pollicis longus* arises from the upper and back part of the *fibula*, and, passing behind the inner angle, it is inserted into the last bone of the great toe.

The *flexor pollicis brevis* ; it ariseth from the *os cuneiforme medium*, and is inserted into the *ossa sesamoidæa* upon the second joint of the great toe.

The *extensor pollicis* arises from near the upper half of the *perone* forwardly ; and, passing under the *ligamentum annulare*, is inserted into the last bone of the great toe.

The *tenar*, or *abducens pollicis*, arises from the *os calcis*, and from the *cuneiforme majus*, and is inserted into the external side of the *sesamoides*.

The *antitenar*, or *abductor pollicis*, arises from

A Table of the Muscles.

from the inferior part of the third *os cuneiforme*, and, passing obliquely, is inserted into the inside of the *ossa sesamoidæa*.

The *transversalis* comes from the bone of the *metatarsus* that sustains the toe next the little toe, and, passing across the other bones, it is inserted into the *os sesamoides* of the great toe: its use is to bring all the toes close to one another.

A TABLE of the MUSCLES.

The muscles
of the fore-
head are one
pair.

FRontales,

They pull the skin of
the forehead up-
wards.

Occipitales,

They pull the skin of
the hindhead up-
wards.

Of the hind
head one
pair.

Attolens } *Auricu-*
Deprimens } *larum.*

Of the ears
six pair.

Internus malleoli,

It distends the *tympa-*
num.

Externus malleoli,

It relaxes the *tympa-*
num.

Obliquus malleoli,

Of the eye-
brows one
pair.

Musculus stapedis,

It moves the stirrup.

Corrugator supercilii,

Eye-lids
two pair.

Rectus palpebræ superi-
oris,

It lifts up the upper
eye-lids.

Orbicularis palpebra-
rum.

It shuts both eye-lids.

A Table of the Muscles.

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<i>Attolens</i>	}	<i>Oculo- rum.</i>	It pulls the eye for- wards and oblique- ly downwards.	Eyes six pair.
<i>Deprimens</i>				
<i>Abductor</i>				
<i>Adductor</i>				
<i>Obliquus major,</i>				
<i>Obliquus minor,</i>			It pulls the eye for- wards, and oblique- ly upwards.	
<i>Attolens</i>	}	<i>Nares.</i>	It pulls the upper lip upwards.	Nose three pair.
<i>Dilatans</i>				
<i>Deprimens</i>				
<i>Incisivus,</i>				
<i>Triangularis,</i>			It pulleth it down- wards.	Lips six pair, and one single one.
<i>Caninus</i>	}		They pull the lower lip upwards.	
<i>Elevator labii infe- rioris,</i>				
<i>Quadratus,</i>				
<i>Zygomaticus,</i>				
<i>Orbicularis,</i>			It pulleth it down- wards.	
<i>Buccinator,</i>			It draws both lips ob- liquely to either side.	
<i>Temporalis,</i>			It draws both lips to- gether.	
<i>Masseter,</i>			It thrusts the meat be- tween our teeth.	Of the checks one pair.
<i>Pterigoidæus internus,</i>	}		They pull the jaw up- wards.	
<i>Pterigoidæus externus,</i>				
			It draws the jaw to either side.	Lower jaw six pair.
			It draws the jaw for- wards.	

Z

Qua

	<i>Quadratus,</i>	It pulleth the jaw and the cheeks downwards.
Uvula two pair.	<i>Digastricus,</i>	It pulleth the jaw downwards.
	<i>Peristaphylinus internus,</i>	It pulls the uvula forwards.
	<i>Peristaphylinus externus,</i>	It pulls the uvula backwards.
Tongue three pair.	<i>Styloglossus,</i>	It draws the tongue upwards.
	<i>Genioglossus,</i>	It pulls it out of the mouth.
	<i>Ceratoglossus,</i>	It pulls it into the mouth.
Os hyoides five pair.	<i>Genihyoidæus,</i>	It pulls os hyoides and tongue upwards and forwards.
	<i>Sternohyoidæus,</i>	It pulleth the os hyoides downwards.
	<i>Mylohyodæus,</i>	It pulls it obliquely upwards.
	<i>Coracohyoidæus,</i>	It pulls it obliquely downwards.
	<i>Stylohyoidæus,</i>	It pulls it to either side, and somewhat upwards.
Of the pharynx, two pair.	<i>Stylo-pharyngæus,</i>	It pulleth up and dilateth the pharynx.
	<i>Oesophagus,</i>	It straitens the pharynx.
Larynx, seven pair.	<i>Sternothyroidæus,</i>	It pulls the thyroides downwards.
	<i>Thyothyroidæus,</i>	It pulls the thyroides upwards.
	<i>Cricothyroidæus,</i>	

Cricothyroideus posticus.

Cricothyroideus lateralis,

Thyrothyroideus,

Athyroideus,

Splenius,

Complexus,

Rectus major,

Rectus minor,

Obliquus inferior,

Obliquus superior,

Mastoidæus,

Rectus internus major,

Rectus internus minor,

Rectus lateralis,

It dilates the *glottis*.

It contracts the *glottis*.

} They move the head Head two pair.
backwards.

} They nod the head
backwards.

} They perform the semi-circular motion
of the head.

} They nod the head
forwards.

It nods the head to
one side.

*Intercostales interni
et externi,*

Subclavius,

Serratus anticus major,

Serratus posticus superior,

Triangularis,

} They pull the ribs up- Of the tho-
rax twenty-
nine pair.
wards in inspiration.

Serratus posticus inferior,

Sacrolumbaris,

Diaphragma,

{ They make the motion of the ribs
downwards, in expiration, the swifter.

Its use is both in inspiration, and expiration.

Lower belly five pair. *Obliquus externus,*
Obliquus internus,
Transversalis,
Rectus,
Pyramidalis,

They compress all the parts contained in the lower belly; assist the motion of the ribs downwards in expiration, and help to bend the *vertebræ* of the loins forwards.

Of the *vertebræ* seven pair. *Longissimus dorsi,*
Transversalis dorsi,
Interspinalis,

It keeps the body erect.

It moves the body obliquely backwards.

It draws the acute processes nearer one another.

Quadratus lumborum, It draws the *vertebræ* of the loins to one side.

Longus,
Scalenus,
Psoas parvus,

They bend the *vertebra* of the neck.

It helps to bend the *vertebræ* of the loins.

The muscles of the privities in men are four pair. *Cremaster,*

It draws up the testicles in the act of generation.

Erectores penis,
Transversalis penis,
Acceleratores urinæ,
 Clitoris one pair. *Erectores clitoridis,*

Sphincter

<i>Sphincter vesicae,</i>	It contracts the neck of the bladder, that the urine may not run continually.	One single muscle of the bladder.
<i>Levatores ani,</i>	They draw up the anus.	Of the anus three single muscles.
<i>Sphincter ani,</i>	It shuts the anus.	
<i>Serratus anticus minor,</i>	It draws the shoulder-blade forwards.	Of the shoulder-blades.
<i>Trapezius,</i>	It moves it upwards, backwards, and downwards.	
<i>Rhomboides,</i>	It pulls it backwards.	
<i>Levator scapulae,</i>	It pulls the shoulder-blade upwards.	
<i>Deltoides,</i>	} They lift the arm upwards.	Of the shoulder-bones, nine pair.
<i>Supra spinatus,</i>		
<i>Coracobrachialis,</i>	} They pull the arm downwards.	
<i>Teres major,</i>		
<i>Latissimus dorsi,</i>	} It moves the arm forwards.	
<i>Pectoralis,</i>		
<i>Infra spinatus,</i>	} They draw the arm backwards.	
<i>Transversalis,</i>		
<i>Subscapularis,</i>	} They bend the fore arm.	Cubiti, six pair.
<i>Biceps,</i>		
<i>Brachialis internus,</i>	} They extend the fore arm.	
<i>Longus,</i>		
<i>Brevis,</i>		
<i>Brachialis externus,</i>		
<i>Anconæus,</i>		

Of the radii, *Rotundus*,
four pair. *Quadratus*,

Longus,
Brevis,

Wrists, four
pair.

Cubitaëus internus,
Radiaëus internus,
Cubitaëus externus,
Radiaëus externus,
Palmaris,

Of the
palms of
the hands,
two pair.

Palmaris brevis,

Of the fin-
gers, fifteen
pair.

Sublimis,
Profundus,
Extensor digitorum
communis,
Lumbricales,

Interossei interni,

Interossei externi,

The parti-
cular mus-
cles of the
thumbs are
seven.

Flexor pollicis longus,
Flexor pollicis brevis,
Extensor primi,
— *secundi*,
— *tertii internodii*,
pollicis,

{ They perform the
motion of *prona-*
tion, or they turn
the palm of the
hand downwards.

{ They perform the
motion of *supina-*
tion, or they turn
the palm of the
hand upwards.

} They bend the wrist.

} They extend the wrist.

It helps the hand to
grasp any thing
closely.

It makes the palm of
the hand concave.

} They bend the fin-
gers.

They assist in bending
the first joint of the
fingers

They draw the fingers
to the thumb.

They draw the fingers
from the thumb.

Tenar

<i>Tenar,</i>	It draws the thumb from the fingers.	
<i>Antitenar,</i>	It draws the thumb to the fingers.	
<i>Abductor indicis,</i> <i>Extensor indicis,</i> <i>Hypotenar,</i>	It draws the little finger from the rest.	Of the fore-fingers, two. Of the little fingers, two pair.
<i>Extensor auricularis,</i> <i>Psoas,</i> <i>Iliacus,</i> <i>Pectinæus,</i> <i>Glutæus major,</i> <i>Glutæus medius,</i> <i>Glutæus minor,</i> <i>Triceps,</i>	They bend the thigh. They extend the thigh. It pulls the thigh inwards.	The muscles of the thighs are thirteen pair.
<i>Pyriformis,</i> <i>Gemini,</i> <i>Quadratus,</i>	They move the thigh outwards.	
<i>Obturator internus,</i> <i>Obturator externus,</i>	They help to move the thigh obliquely, and circularly.	
<i>Semi-nervosus,</i> <i>Semi-membranosus,</i> <i>Biceps,</i> <i>Gracilis,</i> <i>Rectus,</i> <i>Vastus externus,</i> <i>Vastus internus,</i> <i>Cruræus,</i> <i>Sartorius,</i>	They bend the leg. They extend the leg. It makes the legs cross one another.	Of the legs eleven pair.
<i>Poplitæus,</i>	It turns the leg somewhat inwards.	

Mem-

A Table of the Muscles.

	<i>Membranofus,</i>	It turns it a little outwards.
Of the feet, eight pair.	<i>Tibialis anticus,</i>	} They bend the foot.
	<i>Peronæus anticus,</i>	
	<i>Gastrocnemii,</i>	} They extend the foot.
	<i>Soleus,</i>	
	<i>Plantaris,</i>	} It moveth the foot inwards.
	<i>Tibialis posticus,</i>	
	<i>Peronæus posticus,</i>	It moveth the foot outwards.
Of the toes, twenty-four pair.	<i>Profundus,</i>	} They bend the four lesser toes.
	<i>Sublimis,</i>	
	<i>Lumbricales,</i>	} They extend the four lesser toes.
	<i>Longus,</i>	
	<i>Brevis,</i>	} It draws the great toe from the rest.
	<i>Flexor pollicis,</i>	
	<i>Extensor pollicis,</i>	} It draws it to the rest.
	<i>Tenar,</i>	
	<i>Antitenar,</i>	} They draw the toes to the great toe.
	<i>Flexor pollicis longus,</i>	
	—— <i>brevis,</i>	} They draw them from the great toe.
	<i>Abductor minimi digiti,</i>	
	<i>Interossei interni,</i>	} It brings all the toes close to one another.
	<i>Interossei externi,</i>	
	<i>Transversalis,</i>	

In all 446 single muscles in the body.

CHAP.

C H A P. VII.

Of the Nerves, Veins, and Arteries.

S E C T. I.

Of the Nerves in general.

A Nerve is a long and small bundle of very fine pipes, or hollow fibres, wrapt up in the *dura* and *pia mater*; which last not only covers them all in common, but it also encloses every fibre in particular,

The medullary substance of the brain is the beginning of all the nerves; and it is probable that each fibre of the nerves answers to a particular part of the brain at one end, and to a particular part of the body at its other end: that whenever an impression is made upon such a part of the brain, the soul may know that such a part of the body is affected.

The nerves do ordinarily accompany the arteries through all the body, that the animal spirits may be kept warm and moving by the continual heat and pulse of the arteries. They have also blood-vessels as the other parts of the body: these vessels are not only spread upon their coats, but they run also amongst their medullary fibres, as may be seen amongst the fibres of the *retina*. Where-ever any nerve sends out a branch, or receives one from another, or where

where two nerves join together, there is generally a *ganglio* or *plexus* either less or more, as may be seen at the beginning of all nerves of the *medulla spinalis*, and in many other places of the body.

S E C T. II.

Of the Nerves which come immediately out of the Skull.

THE nerves are divided into those which come immediately out between the *vertebræ*. The first sort come from the *medulla oblongata*, which has been already described, and they are ten pair.

Nervi ol-
factorii.

The first pair are called *nervi olfactorii*; they arise from the basis of the *corpora striata*, and passing through the little holes of the *os cribriforme*, they are spread upon the membrane which covers the *os spongiosum*.

Optici.

The second are called *optici*; they rise partly from the extremities of the *corpora striata*, and partly from the *thalami nervorum opti-
corum*, which last they almost embrace; from thence approaching one another, they unite above the *cella turcica*, and immediately dividing again they pass through the foremost holes of the *os sphænoides* into the orbit, where piercing the globe of the eye, their medullary fibres are spread upon the glassy humour.

Oculorum
motores.

The third are called *oculorum motores*; they arise from the *medulla oblongata* on each

each side of the *infundibulum*, and the carotid arteries ly between them; from thence passing through the *foramina lacera* of the *os sphenoides*, they give a branch which, with a branch of the fifth pair, forms a considerable *plexus*, which sends out several twigs which embrace the optic nerve, and are spent on the tunics of the eye: they give a branch to the muscles called *attolens*, *deprimens*, and *obliquus minor* of the globe.

The fourth pair are called *pathetici*; they arise from a small medullary cord that is behind the *testes*; they go down upon the sides of the *medulla oblongata*, and passing under the *dura mater* by the sides of the *cella turcica*, they go through the *foramen lacerum*, and are wholly spent on the *obliquus major*. Pathetici.

The fifth pair rise from the fore part of the *processus annularis*; they are the biggest pair of the brain; they give nerves to the *dura mater*; each of them divides into three branches, of which the foremost is called *ramus ophthalmicus*, because it passes through the *foramen lacerum* into the orbit, where it divides into two branches. The first sends out a branch which joins a branch of the *motores*, and forms the *plexus ophthalmicus*; the rest of this first branch passes over the globe of the eye, gives some twigs to the *glandula lachrymalis*, and goes out at the hole of the *os frontis* above the circumference of the orbit, where it is distributed in the skin and frontal muscles. The second branch of the *ramus ophthalmicus* goes under the muscle *superbus*, and passes out at the hole The fifth pair.

hole called *orbiter internus*, and is distributed in the internal nose.

The second branch of the fifth pair, which passes out of the third hole of the *os sphænoïdes*, divides into three branches, of which one pierces the hind side of the *os maxillare*, and gives twigs to the teeth of the upper jaw; all the rest of it comes out at the hole in the fore side of the same bone, under the orbit, and is distributed into the cheeks and nose. Another passes under the *processus zygomaticus*, and is distributed in the temporal muscle; and the third is distributed in the palate and muscles of the *pharynx*.

The third branch of the fifth pair passes through another hole of the *os sphænoïdes*, and then it divides into two branches; the first of which is again divided into four branches, of which the first passes between the condyle and the *corone* of the lower jaw, to the *masseter*. The second is distributed in the *crotaphites*. The third passes under the *processus zygomaticus* to the *buccinator*, glands of the cheeks, and upper lip. And the fourth passes from behind the condyle of the lower jaw, where it joins the *portio dura* over the jaw, and is distributed in the face. The second branch is divided into three others. The first passes between the *pterygoideus externus* and the *internus*; and towards the angle of the lower jaw it sends out a branch which makes the *chorda tympani*, which goes also to the muscles of the *malleolus*, and then it joins the *portio dura* before it comes out of the *cranium*; the rest spread on the chin. The second goes a-
long

long the sides of the tongue, and sends out several branches which join the ninth pair. It gives also some twigs to the *glandulae sublinguales*, to the muscles of the tongue and *os hyoides*. The third goes to the teeth of the lower jaw, by the holes in its inside.

The sixth pair of nerves arise from the sides of the *processus annularis*. This is a small nerve which passes straight through the *foramen lacerum*, and is wholly spent on the *musculus abducens*. But a little before it enters the orbit, it casts back a branch which alone makes the root of the intercostal nerve. It passes out of the skull by the same passage the carotid artery enters. As soon as it is come out of the skull, it, with a branch of the tenth pair, and of the first and second of the *vertebrae* of the neck, forms a large *plexus* called *cervicalis*. Below this, it receives a branch made of a twig of the tenth pair, and of the first of the neck. As it descends, above the *musculus scalenus*, and below the eighth pair, it receives a branch from each of the *vertebral* nerves. When it comes to the *clavicula*, it divides into two branches, of which one passes above the axillary artery, and the other under it, and then they immediately join again: They, with a branch of the first pair of the back, form a pretty large *plexus* at this place; and sometimes before (for it observes no regularity) it casts out a branch, which, with a branch of the eighth pair, forms the *plexus cardiacus*; then it goes down the cavity of the *thorax*, under the

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pleura

pleura near the *vertebræ*, and as it passes by, it receives a branch from every pair of the back, by which it grows bigger and bigger. As it goes out of the *thorax* it divides into several branches, of which the three superior in the right side form the *plexus hepaticus*, and in the left the *plexus splenicus*. These *plexuses* furnish nerves to the kidneys, to the *pancreas*, to the caul, to the lower part of the stomach, to the spleen, to the liver, to the mesentery, to the intestines; and their branches form a large net upon the mesenterick arteries, called *plexus mesentericus*. The inferior branches, as they go down upon the *vertebræ* of the loins, receive a branch from the first of the loins, and they send out branches which join those of the superior branches which go to the guts, and which form the net upon mesenterick arteries. Then they go down into the basin, and form a large *plexus* above the straight gut, to which it gives nerves, as also the bladder, *vesiculæ seminales*, *prostatæ* in men, and to the womb and *vagina* in women.

Nervus auditorius.

The seventh pair is the *nervus auditorius*; it arises from the hind part of the *processus annularis*; it enters the hole in the inner process of the *os petrosum*; it divides into two branches; that which is soft is called *portio mollis*, and it is distributed into the labyrinth *cochlea*, and membranes which cover the cavities of the ear. That which is hard, is called *portio dura*; it goes out of the ear by that hole which is between the *processus mastoïdes* and *styloïdes*, it divides into two branches,

branches, of which one goes to the muscles of the tongue, or *os hyoides*, and it gives a small branch to the eighth pair. The other is distributed in the external ear, nose, lips, and cheeks.

The eighth pair is the *par vagum*; it Par vagum. rises from the sides of the *medulla oblongata*, behind the *processus annularis*, by several threads which join together, and go out by the same hole that the *sinus laterales* discharge themselves into the *jugulares*. It is joined by a branch of the *nervus spinalis*, or *accessorius willisii*, and by a small branch of the *portio dura*: immediately after it comes out of the skull, it gives a small branch to the *larynx*, as it goes down the neck, above the intercostal nerve, by the side of the internal carotide. At the axillary artery it casts back the recurrent nerves, of which the right embraces the axillary artery, and the left the *aorta*. These two branches ascend on each side of the *trachea arteria* to the *larynx*, where they are spent on the muscles of the *larynx* and membranes of the *trachea*.

Then the eighth pair, after it has entered the cavity of the *thorax*, sends out two branches, which, with the branches of the two intercostals, form, a little above the heart, between the *aorta* and the *trachea*, the *plexus cardiacus*, which gives a great number of small branches of the *pericardium* and heart, particularly very many creep along the *aorta* to the left ventricle. The eighth pair gives also several branches to the lungs, which accompanying the *bronchi*,

then it descends upon the *oesophagus*, and is spread upon the stomach; and some twigs go to the concave side of the liver, as has been said already.

With this nerve it is usual to describe another which passes out of the skull at the same hole with it. It is called *nervus accessorius willisii*; it arises from the *medulla spinalis*, about the beginning of the sixth pair of the neck; as it ascends to the head, it receives on each side a twig from the first five pair of nerves of the neck, as they rise from the *medulla spinalis*; then it enters the skull, and passes out of it again with the eighth pair, and is wholly spent upon the *musculus trapezius*.

The ninth
pair.

The ninth pair rises from the *processus olivares* of the *medulla oblongata*; it passes out of the skull by its own proper hole in the *os occipitis*: as it passes to the tongue, it gives some branches to the muscles of the *os hyoides*; but its trunk is distributed in the body of the tongue, and its extremities from the *papilla rotundæ* of the tongue.

The tenth
pair.

The tenth pair rises by several small threads from the beginning of the *medulla spinalis*; then, ascending a little, it goes out of the same hole of the *dura mater* at which the vertebral artery enters, passing between the protuberance of the *occiput* and the first *vertebra*, in the *sinus*, which we have observed in this *vertebra*: then it gives a branch to the first pair of the neck which goes to the *plexus cervicalis*; it gives the second pair, and a third, to the intercostal nerve; and

and then it is all spent on the oblique muscles of the head.

S E C T. III.

*Of the Nerves which come out between the
Vertebræ.*

THE nerves which come out between the *vertebræ* are thirty pair; they arise from the *spinalis medulla*, which (as we have said before) is a continuation of the *substantia medullaris*, or *medulla oblongata* of the brain, contained in the great holes of the *vertebræ*. Its internal substance is mixed in several places with a substance like the cortical substance of the brain, (as *Malpighius* has observed.) From the first *vertebra* of the neck to the first of the loins, it is divided by the *pia mater* into the right and left side, not quite through its middle, but the depth of a line or two in its fore and hind part. From the first of the loins to its extremity, it is divided into a great number of fibres, which separate from one another, if they be shaken in warm water. This part, because of its resemblance, is called *cauda equina*; it is covered by four membranes, of which the first is that which lines the great holes of the *vertebræ*. The second is the *dura mater*, which has two *sinuses*, one on each side of the *medulla*; they reach from the *occiput* to the last of the *os sacrum*. The third is the *pia mater*: and the fourth, called *arachnoides*, is a very

fine membrane, which contains only the bundles of fibres which make the vertebral nerves.

All the nerves, as they rise out of the *medulla spinalis*, are by the *pia mater* divided into two plans, which ly one above the other. And as soon as the nerves are come out of the *vertebræ*, they send a branch to one another, where they make a little *ganglio*.

The nerves of the *vertebræ* are thirty pair, seven of the neck, twelve of the back, five of the loins, and six of the *os sacrum*; they come out at the holes in the sides of the bodies of the *vertebræ*, which have been taken notice of in the *osteology*.

Of the
nerves of
the neck.

The first pair of the neck is spread in the muscles of the head and neck; it joins a branch of the tenth pair which goes to the *plexus cervicalis*, and it gives another branch to the intercostal pair below the *plexus*.

The second pair of the neck gives also nerves to the muscles of the head and neck, to the external ear and skin of the face.

The third gives some branches to the neck and head; it sends out the *nervus diaphragmaticus*, being joined by a branch from the fourth pair. This nerve goes straight down the cavity of the *thorax*, and is spread on the midriff.

The fourth, fifth, sixth, and seventh, give some branches to the muscles of the neck and head; but their greatest branches, together with a branch of the first of the back, enter the arms. As soon as they enter, they join all together, and then they
imme-

immediately divide into five branches. The first and innermost goes all to the skin which covers the inner and fore part of the arm. The second goes down by the inner protuberance of the *humerus*, by the benders of the fingers; and in the palm of the hand it divides into five branches, of which one goes to each side of the little and ring-finger, and the fifth to the external side of the middle finger. The third accompanies the artery between the *sublimis* and the *profundus*; it divides also into five branches, of which one goes to each side of the thumb and fore finger, and the fifth to the internal side of the middle finger. The fourth passes under the *biceps* to the outer side of the arm, and back of the hand, to be distributed into the fingers, as the foregoing. The fifth is spent on the muscles on the inside of the arm. All these nerves, except the first, give branches to the muscles as they pass by.

The first pair of the twelve pair of the back gives a branch (as is said) to the arms. The twelfth pair is dispersed in the muscles of the lower belly, and all the rest run along the *sinus* in the under side of the rib, giving nerves to all the muscles that ly upon the ribs and *vertebrae*.

Of the nerves of the back.

The first and second pair of the loins give nerves to the muscles of the lower belly, to the *inguen*, to the yard, and to the parts contained in the bason. The third and fourth give some branches to the same parts; but their trunks join, and make the *nervus anterior femoris*, which is dispersed in

Of the nerves of the loins.

in the fore part of the thigh. This nerve sends a branch through the hole in the *ischium*, which is spent in the *triceps*. The last of the loins, with a branch of the fourth, enter the thigh.

Of the
nerves of
the os sa-
crum.

The nerves of the *os sacrum* come not out at the holes on its backside, but at those on its foreside; and the last comes out between the extremity of the *os sacrum* and the *os coccygis*.

The first four pair of the *os sacrum* gives some twigs to the parts in the basin; but their great branches, with the last, and a branch of the fourth of the loins, make the *nervus sciaticus*, which is the greatest nerve in the whole body. As this nerve passes between the *gracilis posterior* and the *semitransversarius*, it gives a branch to the skin. When it comes to the ham, it divides into two, of which one goes along the *perone* to the upper part of the foot, and gives a branch to both sides of each toe, the other passes under the *gemelli* by the inner ancle, and is distributed in like manner to the toes in their under sides.

The fifth and sixth of the *os sacrum* are very small, they are dispersed in the sphincter and bladder and natural parts.

S E C T. IV.

Of the Arteries in general.

THE *arteries* are conical channels which convey the blood from the heart to all the parts of the body.

Each

Each artery is composed of three coats, of which the first seems to be a web of fine blood-vessels and nerves, for the nourishing of the coats of the artery. The second is made up of circular, or rather spiral fibres, of which there are more or fewer *strata*, according to the bigness of the artery. These fibres have a strong elasticity, by which they contract themselves with some force, when the power by which they have been stretched out ceases. The third and inmost coat is a fine, dense, transparent membrane, which keeps the blood within its channels, which otherwise, upon the dilatation of the artery, would easily separate the spiral fibres from one another. As the arteries grow smaller and smaller, so these coats grow thinner, and the coats of the veins seem to be only a continuation of the coats of the capillary arteries.

The structure of the arteries being thus premised, it will be easy to account for their pulse. When the left ventricle of the heart contracts, and throws its blood into the great artery, the blood in the artery is not only thrust forwards towards the extremities, but the channel of the artery is likewise dilated; because fluids, when they are pressed, press again to all hands, and their pressure is always perpendicular to the sides of the containing vessels; but the coats of the artery, by any small *impetus*, may be distended; therefore, upon the contraction of the heart, the blood from the left ventricle will not only press the blood in the artery forwards, but both together will distend the sides.

sides of the artery. When the *impetus* of the blood against the sides of the artery ceases, that is, when the left ventricle ceases to contract, then the spiral fibres of the artery, by their natural elasticity, return again to their former state, and contract the channels of the artery, till it is again dilated by the systole of the heart. This diastole of the artery is called its pulse, and the time the spiral fibres are returning to their natural state, is the distance between two pulses. This pulse is in all the arteries of the body at the same time; for whilst the blood is thrust out of the heart into the artery, the artery being full, the blood must move in all the arteries at the same time; and because the arteries are conical, and the blood moves from the basis of the cone to the *apex*, therefore the blood must strike against the sides of the vessels, and consequently every point of the artery must be dilated at the same time that the blood is thrown out of the left ventricle of the heart; and as soon as the elasticity of the spiral fibres can overcome the *impetus* of the blood, the arteries are again contracted. Thus there are two causes, which, operating alternately, keep the blood in a continual motion, *viz.* the heart and fibres of the arteries: but because the one is stronger than the other, therefore, though the blood runs continually, yet, when an artery is opened, it is seen to move *per saltum*.

S E C T. V.

Of the Trunk of the Aorta Ascendens.

AS all the blood of the body passes thro' the heart, so all is conveyed by the branches of the *aorta*, or great artery, to the several parts of the body, in the order we are now to describe.

The *aorta*, coming from the left ventricle of the heart, sends out two branches called *coronariæ* to the heart, before it pierces the *pericardium*; but, after it hath pierced it, it ascends a little, and then it crooks downwards and forms the *aorta descendens*. From the upper side of this crook it sends out three branches, two on the left side, which are one subclavian and one carotide; one on the right side, which is the right subclavian, from which immediately arises the right carotide.

The *arteriæ subclaviæ* on each side send out the *mediastina*, the *mammaria*, the *cervicalis* or *vertebralis*; and a branch which goes to the muscles of the neck, of the breast, and to the *glandulæ thyroides*. After the *subclavian* has passed through the *musculus scalenus*, it is called *axillaris*.

The *arteriæ carotides*, as they ascend on each side of the *trachea arteria*, give some small branches to the *trachea arteria*, to the *larynx*, to the *glandulæ thyroides*; and then they send out each four considerable branches.

The

Of the Trunk of the Aorta, &c.

The first goes to the tongue, to the muscles of the *os hyoides*, and to the *pharynx*.

The second divides into two branches, of which the first loses itself in the muscles *mylohyoides* and *digastrici*, and the second goes along the basis of the lower jaw, and is lost in the muscles of the lips.

The third branch divides at the angle of the lower jaw into two branches; one enters into the lower jaw, and the other makes the *arteria temporalis*.

The fourth branch goes to the muscles on the hind part of the neck, and to the skin of the hind head.

The carotide then passes through the canal in the *os petrosum*, gives some branches to the *dura mater*, joins with the *cervicalis*, sends out branches to the *glandula pituitaria*, *rete mirabile*, *plexus choroides*; then it runs through all the circulations of the *cerebrum* and *cerebellum*, and loses its capillary branches in their carotidal substance.

The *axillaris*, having pierced the *scalenum*, gives some little branches to the nearest muscles; it sends out the *thoracica superior* and *inferior*, the *scapularis*; and then it gives a branch which passes under the head of the *humerus* into the *musculus longus* and *brevis* of the arm.

The trunk of the *axillaris* goes down the inside of the arm, giving branches by the way to the muscles that ly upon the *humerus*. Above the elbow it sends out a branch which is spread upon the internal condyle of the *humerus*.

The external runs along the *radius*, it casts out a branch which goes to the *supinator*, and ascends to the *brachialis internus*; in the rest of its course down to the wrist, it gives branches to the *longus rotundus*, and benders of the fingers, wrist, and thumb. Being come to the wrist, it sends out a branch which goes to the beginning of the *tenar*, then it passes under the tendon of the *flexor pollicis*; it gives branches to the external part of the hand, and passing under the tendons of the muscles, its branches run along each side of the thumb and fore finger.

S E C T. VI.

THE *aorta descendens* sends out first the *brunghialis* of M. Ruyfch, which accompanies all the branches of the *bronchia*. As it descends along the *vertebræ* of the *thorax*, it sends out on each side the intercostal arteries. To the *diaphragma* it gives the *phrenica*; and the *cæliaca* is the first it sends out when it enters the *abdomen*. The *cæliaca* divides into two branches, the one

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on the right, the other on the left; of which the first gives the *gastrica dextra* which goes to the stomach, the *cystica* to the gall-bladder, the *epiplois dextra* to the *omentum*, the *intestinalis* to the intestine *duodenum*, and to a part of the *jejunum*, the *gastro-epiplois* to the stomach, to the *omentum*, and some branches to the liver, which enter the *capsula communis*, to accompany the branches of the *vena portæ*.

The left branch of the *cæliaca* gives the *gastrica dextra*, which is also spread on the stomach, the *epiplois sinistra* to the *omentum*, and the *splenica* to the substance of the spleen.

Then the *aorta descendens* sends out the *mesenterica superior*, the *renales* or *adiposæ*, which go to the *glandulæ renales*, and fat about the reins, emulgents to the reins; the *spermaticæ* to the testicles, the *lumbares inferiores* to the muscles of the loins, the *mesenterica inferior*, which, with the superior, is distributed through all the *mesenterium*, and which accompanies all the branches of the *venæ mesenteriacæ*. When the *aorta* is come to the *os sacrum*, it divides into two great branches; and from the angle they make, springs out a small artery called the *sacra*, because it is spread upon the *os sacrum*. The iliac arteries divide again into the external and internal iliacks.

From the internal iliack arises the *hypogastrica*; it is distributed to the bladder, to the *rectum*, to the outer and inner side of the *matrix*, *vagina*, *vesiculæ seminales*, *prostatæ*, and *penis*, to the *os sacrum*, and to all the parts

parts contained in the *pelvis*, or *basin*. Then it gives two considerable branches, which go out of the lower belly. The first passes under the *pyriformis*, and is distributed to the muscles called *glutæi*. The second, which is lower than the first, gives also two branches pretty big, of which the first goes to the *obturatores*, the second pierces the cavity of the *abdomen*, under the *pyriformis*, and loses itself by several branches in the *glutæus major*.

As soon as the external iliack leaves the cavity of the *abdomen*, it sends out the *epigastrica*, which runs up the inside of the *musculus rectus*; and a little below that, the *pudenda*, which goes to the privities. Then it is called *cruralis*, which sends out three considerable branches.

The first is called *muscula*, which gives several branches. The first passes between the muscles called *iliacus* and *pectinæus*, and loses itself in the third head of the *triceps*, in the *semi-membranosus*, or *semi-nervosus*, in the beginning of the *biceps*, in the *quadrifidus*, and in the cavity of the great *trochanter*.

The second, third, and fourth, go to several parts of the *triceps* and *gracilis posterior*.

Then the trunk of the *muscula* goes under the first of the *triceps*, and divides into three branches more.

The first having passed the third of the *triceps*, is lost in the *semi-membranosus*. The second passes under the *femur* to the *vastus externus*. The third goes a little lower, casts branches to the tendon of the

on the right, the other on the left; of which the first gives the *gastrica dextra* which goes to the stomach, the *cystica* to the gall-bladder, the *epiplois dextra* to the *omentum*, the *intestinalis* to the intestine *duodenum*, and to a part of the *jejunum*, the *gastro-epiplois* to the stomach, to the *omentum*, and some branches to the liver, which enter the *capsula communis*, to accompany the branches of the *vena portæ*.

The left branch of the *cæliaca* gives the *gastrica dextra*, which is also spread on the stomach, the *epiplois sinistra* to the *omentum*, and the *splenica* to the substance of the spleen.

Then the *aorta descendens* sends out the *mesenterica superior*, the *renales* or *adiposæ*, which go to the *glandulæ renales*, and fat about the reins, emulgents to the reins; the *spermatica* to the testicles, the *lumbares inferiores* to the muscles of the loins, the *mesenterica inferior*, which, with the superior, is distributed through all the *mesenterium*, and which accompanies all the branches of the *venæ mesenteriacæ*. When the *aorta* is come to the *os sacrum*, it divides into two great branches; and from the angle they make, springs out a small artery called the *sacra*, because it is spread upon the *os sacrum*. The iliac arteries divide again into the external and internal iliacks.

From the internal iliac arises the *hypogastrica*; it is distributed to the bladder, to the *rectum*, to the outer and inner side of the *matrix*, *vagina*, *vesiculæ seminales*, *prostatæ*, and *penis*, to the *os sacrum*, and to all the parts

parts contained in the *pelvis*, or basin. Then it gives two considerable branches, which go out of the lower belly. The first passes under the *pyriformis*, and is distributed to the muscles called *glutæi*. The second, which is lower than the first, gives also two branches pretty big, of which the first goes to the *obturatores*, the second pierces the cavity of the *abdomen*, under the *pyriformis*, and loses itself by several branches in the *glutæus major*.

As soon as the external iliack leaves the cavity of the *abdomen*, it sends out the *epigastrica*, which runs up the inside of the *musculus rectus*; and a little below that, the *pudenda*, which goes to the privities. Then it is called *cruralis*, which sends out three considerable branches.

The first is called *muscula*, which gives several branches. The first passes between the muscles called *iliacus* and *pectinæus*, and loses itself in the third head of the *triceps*, in the *semi-membranosus*, or *semi-nervosus*, in the beginning of the *biceps*, in the *quadrigemini*, and in the cavity of the great *trochanter*.

The second, third, and fourth, go to several parts of the *triceps* and *gracilis posterior*.

Then the trunk of the *muscula* goes under the first of the *triceps*, and divides into three branches more.

The first having passed the third of the *triceps*, is lost in the *semi-membranosus*. The second passes under the *femur* to the *vastus externus*. The third goes a little lower, casts branches to the tendon of the

third of the *triceps*; it loses itself at the end of the *semi-nervosus*, and at the end of the great head of the *biceps*.

The second considerable branch of the trunk of the crural goes to the external part of the thigh. passes under the *sartorius*, under the *gracilis rectus*; it casts some branches to the end of the *iliacus*, to the beginning of the *gracilis rectus*, to the *vastus externus*, *cruralis*, *membranosus*, and fore part of the *glutæus minor*.

The third rises almost from the same part of the crural, and loses itself in the middle of the *gracilis*, *rectus*, *cruralis*, and *vastus externus*.

The crural having sent out these three branches, gives several branches to the *sartorius*, to the *gracilis posterior*, but the greatest goes to the *vastus externus*.

As the crural descends, it sinks the deeper in the hind part of the thigh, passing through the tendons of the *triceps*: Being come to the ham, the first branch it sends out is spread on the hind part of the thigh bone, and it goes to the little head of the *biceps*; then it casts out several other branches, which lose themselves in the fat, and in the extremities of the muscles behind the *femur*. Under the ham it sends out two *poplitææ*, which go round the knee, the one in the inside, the other in the outside. It casts out, a little lower, several other branches, of which some go to the beginning of the *gemini*, of the *solaus plantaris*, and *popliteus*; and the rest surround the *tibia* on all sides.

Then

Then it divides into two branches, of which the first passes through the membrane, which joins the *tibia* and *perone* together; upon which it continues its way, giving branches to the *tibiæus externus*, and to the *extensores digitorum*.

The second branch divides into two more, the one external, the other internal.

The external, after it hath given branches to the *solæus*, to the *peronæus posterior*, and to the *flexor pollicis*, pierces the membrane between the *tibia* and *perone*; rises upon the external angle, to spread itself upon the upper part of the foot.

The internal, as it descends, gives branches to the *solæus*, to the *flexores digitorum*, to the *tibiæus posterior*; then it passes by the cavity of the *perone*, where it divides into two branches, of which one passes under the *tenar* to the great toe, the other passes between the *musculus brevis* and the *hypotenar*, and is distributed into the other three toes.

This is the order and distribution of the principal arteries in the body, each of which are subdivided into others, and these again into others, till at last the whole body is overspread with most minute capillary arteries; concerning which there are two things remarkable: First, that the branches which go off at any small distance from the trunk of an artery, unite their canals into one trunk again, whose branches likewise communicate with one another, and with others, as before. By this means, when any small artery is obstructed, the blood is brought by the communicating branches to the parts

Of the Aorta Descendens.

below the obstruction, which must otherwise have been deprived of their nourishment. These inosculations are apparent every where, but chiefly in the *uterus*, mesentery, and brain. It is the same thing with the veins.

The other thing is, that the sum of the orifices of the branches of any artery is greater than the orifices of the trunk from which they came; and upon this consideration the velocity of the blood is mightily diminished as it removes from the heart. The proportions the primary branches bear to one another, and the *aorta* to the *cava* and pulmonary artery, are as follows;

The <i>aorta</i>	100000
Right subclavian artery	20101.9
Left carotide	10016
Left axillary	14456.7
Bronchal artery	434.2
24 Intercostals, each 434.2	10420.8
Cæliack	4830.3
Mesenterick	7307.8
Right emulgent	4639
Left emulgent	4639
Inferior mesenterick	3015
5 Lumbals, each 434.2	2605.2
Left iliack	9739.8
Right iliack	10535
The sum of all the branches	102740.7

Th

The pulmonary artery	139291.8
The ascending <i>cava</i> .	92373
The descending <i>cava</i> .	92373

S E C T. VII.

Of the Veins in general.

THE veins are only a continuation of the extreme capillary arteries, reflected back again towards the heart, and uniting their channels as they approach it, till at last they all form three large veins; the *cava descendens*, which brings the blood back from all the parts above the heart; the *cava ascendens*, which brings the blood from all the parts below the heart; and the *porta*, which carries the blood to the liver.

The coats of all the veins are the same with those of the arteries, only the muscular coat is as thin in all the veins, as it is in the capillary arteries; the pressure of the blood against the sides of the veins being less than that against the sides of the arteries.

In the veins there is no pulse, because the blood is thrown into them with a continued stream, and because it moves from a narrow channel to a wider.

The capillary veins unite with one another, as has been said of the capillary arteries.

In all the veins which are perpendicular to the horizon, excepting those of the *uterus* and of the *porta*, there are small membranes

or valves; sometimes there is only one, sometimes there are two, and sometimes three, placed together, like so many half thimbles stuck to the sides of the veins, with their mouths towards the heart, they are pressed close to the sides of the vein; but if blood should fall back, it must fill the valves; and they being distended, stop up the channel, so that no blood can repass them.

S E C T. VIII.

Of the Cava Descendens, or Superior.

FOR the more easy describing of the veins, I shall begin at their trunks, and proceed to their branches contrary to the motion of the blood in them. And first of the *cava descendens*, or that in which the blood returns from all the parts above the heart.

The trunk of the *cava descendens* joins the trunk of the *cava ascendens*, and both together open into the right auricle of the heart. On the inside of the vein, where the trunks join, there is a small protuberance, which hinders the blood which comes from the upper parts, from falling upon that from the inferior parts, but diverts both into the auricle, where the *cava descendens* joins the auricle: it receives the coronary vein of the heart.

As soon as it pierces the *pericardium*, it receives the *αζυγος*, or *vena sine pari*; this vein runs along the right side of the *vertebrae*

læ of the *thorax*, and is made by the union of the veins of the ribs on each side. Its small end, at the *diaphragma*, is divided into two branches, which communicate with a vein, sometimes from the emulgents, and sometimes from the *cava ascendens*.

The *cava descendens* receives next the *intercostales superior*, which is distributed in the interstices of the four first ribs, to which the *azygos* come not. Remark, That the branches both of the one and the other run in the *sinuses* which are on the lower sides of the ribs.

Sanmichellius hath observed, that the trunk of the *cava descendens* receives a branch called *pneumonica*; it is this branch which accompanies the *arteria bronchialis* of M. Ruyfch.

S E C T. IX.

Of the Venæ Subclaviæ, Jugulares, and their branches.

THE trunk of the *cava descendens*, as soon as it comes to the *clavicula*, where it is sustained by the *thymus*, is divided into two branches, the one goes to the right, the other to the left; they are called *subclaviæ*; which receive several other branches.

The first is the *mammaria*, which comes sometimes into the *cava*, before it divides into the *subclaviæ*; this vein is distributed in the breasts, and frequently it goes lower,
and

and makes an *anastomosis* with some branches of the *epigastrica*.

The second is the *mediastina*, which is ordinarily one opening into the trunk of the *cava*; it goes to the *mediastinum*, and *thymus*.

The third is the *cervicalis*, or *vertebralis*, which goes up the *vertebræ* of the neck, and casts some branches by the bye to the *medulla spinalis*.

The fourth is the *muscula inferior*, which comes sometimes into the jugulars; it is distributed through the inferior muscles of the neck, and the superior of the breast. The branch that answers this is called *muscula posterior*, because it is distributed in the muscles which are in the hind part of the neck.

After that the *rami subclavii* are come out of the cavity of the breast, they are called *axillares*; they receive the *scapularis internus* and *externus*, which goes to the muscles of the *scapula*, and to the glands in the arm-pits: then they are divided into two branches; the superior is called *cephalica*, and the inferior *basilica*.

Into the *basilica* open the *thoracica superior*, which goes to the ducts and muscles of the breast. The *thoracica inferior*, which spreads itself upon the side of the breast, by several branches which communicate by *anastomosis*, with the branches of the *azygos*, under the muscles of the breast.

The *subclavii* receive also the *jugulares externi* and *interni*, which go to the head.

The *jugulares externi* ascend towards the ears,

ears, where they divide into two branches, the one internal, the other external. The internal goes to the muscles of the mouth and of the *os hyoides*. The external lying upon the *parotides*, divide into two branches, of which one is spread through all the face; and the branches of the one side unite with those on the other side, and form the *vena frontis*: the other branch goes to the temples and hind head.

The *jugulares interni* ascend to the basis of the *cranium*, where they are divided into two branches, of which the greatest open into the *sinus laterales* of the *dura mater*, by the holes through which the eighth pair of nerves come out; the least goes to the *pia mater*, by the hole which is nigh the *cella turcica*.

S E C T. X.

Of the Veins of the Arms and Hands.

THE *basilica* and *cephalica* are the two principal veins of the arms and hands.

The *cephalica* creeps along the arm between the skin and the muscles; it divides into two branches.

The external branch goes down to the wrist, where it joins the *basilica*, and turns up to the back of the hand, where it gives a branch which makes the *salvitella* between the ring finger and the little finger. The ancients used to open this vein in diseases of the

Of the Veins of the Arms and Hands.

the head, in continued and intermitting fevers ; but the moderns approve not of this particular practice. Since the knowledge of the circulation of the blood, there is no difference whether one be blooded in the *cephalica*, *mediana*, or *basilica*.

The internal branch of the *cephalica*, together with a branch of the *basilica*, makes the *mediana*.

The *basilica*, which is the inferior branch of the *axillares*, divides into three branches, under the tendon of the *musculus pectoralis*.

The first branch accompanies the fourth branch of the nerves that goes to the arm.

The second is called *profundus* ; it reaches below the elbow, where it divides into two branches : the one external, which goes to the thumb, the fore finger, and to the *musculi extensores carpi* : the other internal, which goes to the middle finger, to the ring finger, to the little finger, and to the inner muscles of the hand.

The third branch is called *subcutaneus* ; towards the inner condyle of the arm, it dives into the *ramus anterior* and *posterior* ; the first goes under the muscles of the *ulna* to the little finger, where it joins the branch of the *cephalica* ; the second, near to the elbow, sends out a branch which goes to the wrist ; then it unites with the *cephalica interior*, and forms the *mediana*.

The *mediana*, which is made of the *cephalica interior*, and the second branch of the *ramus subcutaneus* of the *basilica*, divides into two branches upon the *radius* ; the

one external, called *cephalica pollicis*, which runs between the thumb and the fore finger; the other internal, which goes between the ring finger and the middle finger, and sometimes between this last and the fore finger.

S E C T. XI.

Of the Trunk of the Cava Ascendens, or Inferior.

THE trunk of the *cava ascendens*, between the heart and the *diaphragma*, does not ly upon the *vertebræ*, but runs at a small distance from them. At the *diaphragma* it receives the *phrenica* or *diaphragmatica*. When it has pierced the *diaphragma*, it receives some large branches from the liver; then the *cava ascendens* accompanies the great artery from the liver to the fourth *vertebræ* of the loins, where it divides into two great branches, called *iliaci*; but before this division it receives four branches from each side.

The first is the *vena adiposa*, or *renalis*, which is spread on the coat and fat that covers the reins.

The second is the *vena emulgens*, which goes to the kidneys, where it divides into several more branches.

The third is the *vena spermatica*, of which we have already spoken.

The fourth is the *vena lumbaris*, which is not always one, but often two or three on

each side, which they divide into superior and inferior; they are bestowed on the muscles of the loins, and on the *peritonæum*. They sometimes call the last branch of the *lumbaris, muscula superior*.

There are some anatomists that have observed, that there is a branch of the *lumbaris* that enters the cavity of the *vertebræ*, and which ascends to the brain; which gave them occasion to think, against all probability, that the seed descended by that vein from the brain.

A little below the emulgent, the great artery goes above the *cava*; and then the *cava* divides into two branches called *iliaci*, because they pass above the *ilia* to go to the thighs. Near this division they receive one or two branches called *venæ sacræ*, they go to the *medulla* of the *os sacrum*.

Then the *vena iliaca* divides into two branches, the one internal, the other external. The internal receives two branches, the *muscula media*, which is spread through the muscles of the thigh; the *hypogastrica*, which is sometimes double, and spread about the *sphincter* of the *anus*; therefore it is called their *hæmorrhoidalis externa*. The *hypogastrica* is spread also upon the body of the bladder, upon the *matrix* and its neck.

The external branch of the *iliaca* receives three branches, two before it goes out of the *peritonæum*, and the third after it goes out of it.

The first is the *vena epigastrica*, which comes rarely into the *cruralis*; it goes to the *peritonæum*, ascends to the *musculi recti*, where it

it rencounters the *mammariæ*, with which it communicates by *anastomosis*.

The second is the *vena pudenda*; it is spread upon the parts of generation.

The third is the *muscula inferior*; it goes towards the articulation of the *femur*, and is distributed to the muscles of this part.

The *iliaca exterior*, after it hath received all these branches, takes the name *cruralis*, and then receives six branches more.

The first is the *vena saphæna*, which goes down under the skin along the inside of the thigh and leg, accompanied with a nerve which loses itself at the inner ancle. The *saphæna* turns towards the upper part of the foot, where it gives several branches, of which some go to the great toe.

The second is the *ischias minor*; this vein is little; it is spent on the muscles and skin which are about the upper joint of the *femur*.

The third is the *muscula externa*, because it goes to the external muscles of the thigh. On the other side of the *cruralis*, just opposite to the beginning of this vein, there goes out another called *muscula interna*, which goes to the internal muscles of the thigh.

The fourth is the *poplitea*, made of two different branches united together; it goes straight down by the ham to the heel; it lies pretty deep, upon which account it can hardly be opened. The branches which appear in this place are not of this vein.

The fifth is the *furalis*, which is pretty big, and which divides into two branches;

the one external, which is least ; the other internal, which is biggest. Each of these branches divide again into two more ; the one external, the other internal.

The *suralis* distributes its branches upon the fat of the leg, and makes, with the branches of the *poplitæa*, all those *plexus* of veins which are conspicuous on the upper part of the foot.

The sixth and last branch of the *cruralis* is the *ischias major*, which goes also to the muscles and fat of the leg, and is divided afterwards into several branches, which are distributed to the toes.

S E C T. XII.

Of the Vena Porta.

THUS we have described the veins which come from all the parts of the body, except the stomach, spleen, *pancreas*, *omentum*, and intestines, from which part the blood is carried by the branches of the *porta* to the liver, to be returned by the branches of the *cava* in the liver, after that the bile has been separated from it, as has been said in the *section* of the *liver*.

The *vena porta* was so called by the ancients, because they thought that it brought the chyle by its *meseraick* branches from the intestines to the liver, through whose substance it is spread. As it arises out of the liver, it receives two small veins from the *vesica fellis* called *cysticæ gemellæ*, one from the

the stomach called *gastrica dextra*; then advancing a little to the left, its trunk divides into two branches, of which the least, called *ramus splenicus*, goes to the left *hypocondrium*: and the greatest, called *mesentericus*, goes to the right. The *ramus splenicus*, so called because it carries the blood from the spleen, receives two branches called *gastrica minor, et major*, which are spread through all the stomach. A branch of the *gastrica major* makes the *coronaria stomachica* at the upper orifices of the stomach. It receives three branches more, two from the *omentum* and *colon*, and the third from the *pancreas*.

Then the *splenicus* divides into two branches; the one superior, the other inferior.

The superior receives the *vas breve*, and some other branches which come from the spleen.

The inferior receives two branches, *viz.* the *epiplois sinistra* which is spread through the back part of the *omentum*, and that part of the *colon* which is under the stomach. The other branch is the *gastro-epiplois sinistra*, which is also spread upon the *omentum* and upon the stomach; it makes sometimes the *vena hæmorrhoidalis interna*. The rest of this inferior branch comes from the substance of the spleen.

The right branch of the *porta*, called *vena mesenterica*, before it divides, receives the *gastro-epiplois dextra*, which is spread in the *omentum* and lower part of the stomach; as also the *intestinalis*, which comes from the *duodenum*, and the *jejunum*; it receives

Some branches from the *omentum* and *pancreas*.

Then the *desenterica* divides into three great branches which run betwixt the duplicature of the *mesenterium*. Two of them come from the right side, which divide into fourteen branches; and these are again divided into an infinity of others less, which are called *meseraicæ*; they creep upon the *jejunum*, *ilium*, *cæcum*, and part of the *colon*.

The third and last branch of the *vena mesenterica* is spread through the middle of the *mesenterium*, to that part of the *colon* which is on the left side, to the *rectum*, down to the *anus*, where it forms the *hæmorrhoidales internæ*.

F I N I S.

